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Commercially Paid Junkets

A RECENT news dispatch tells of a trip to be made by certain city commissioners of a Southern town for the purpose of inspecting street paving in Northern cities. The excursion includes New York, Boston and Washington, and, the press report states, "the entire cost of the trip is to be borne by the manufacturers of paving materials." It is to be presumed that these commissioners contemplate a program of paving in their own town and are in quest of information which will enable them to make an intelligent decision in selecting the types of surfacing for their own streets; but this is the last way to proceed. The commission has an engineer and it is his job to advise on the technical matters involved. If the commissioners are to make the decision, why have an engineer? With the paving manufacturers bearing "the entire expense of the trip"—and this is a big order if these officials run "true to form"—it is difficult to understand how these city fathers can make anything but a biased ruling in the selection of materials. To any but the unsophisticated the councilmen are already "bought and paid for."

Electrolytic Treatment of Sewage

IT is probable that sanitary engineers will not receive the results of the electrolytic sewage treatment experiments at Elmhurst, L. I., reported on page 293 of this issue, with quite as much enthusiasm as is displayed by the author, who concludes that "beyond a doubt a satisfactory method of sewage disposal has at last been accomplished." This is a broad statement, particularly since the electrolytic process is primarily one of sterilization and cannot be considered sufficient, without adequate means of sedimentation, for the removal of suspended matter. The sludge problem has been the most difficult one in the art of sewage treatment and it is not clear that the electrolytic process offers a solution. In the cost figures given by Mr. Travis there is included no item of expense for the disposal of sludge nor for supervision and maintenance of the plant. The $8.09 is simply the cost of electric current and chemicals. While this fact is so stated in the report it needs emphasis, for a layman might jump to the conclusion that the figure given represented the total cost of treatment per million gallons, whereas it makes no provision for handling the sludge. If a sterile effluent is the only object of electrolytic treatment the result can be accomplished more cheaply by the use of liquid chlorine or hypochlorite of lime in solution. The report will receive the close study of sanitary engineers.

"Keep the Cars Moving"

WITH the time fast approaching when the railroads will be called upon to move the bumper crops the Public Utilities Commission of Ohio, keenly alive to the situation, has issued a four-page circular appealing to the railroads and shippers of that State to "keep the cars moving." It would be well if the appeal could reach every State, for we are threatened with the most serious car shortage in years. That the railway freight car is able to move, on the average, only as far each twenty-four hours as it goes in two or three while actually on the road is not creditable to present conditions. True, cars must inevitably be withdrawn from service for repairs and time must be lost at inadequate yards and terminals—some of which would have been rebuilt if the railroads had had large revenues in recent years. But withal there is the tendency on the part of both railroad and shipper to blame the other fellow instead of making the best use of the facilities available. Too many cars are crippled by careless switching and are not repaired as promptly as possible. Yards are not operated as designed, or to the best advantage. There is too little team work between division points, resulting in incomplete classifications, and too many of them. As for the shippers, they are looking out chiefly for themselves and have a habit of using cars as warehouses. Other faults are also pointed out by the commission. Twelve suggestions are directed to the railroads and twelve to the shippers. The first in each case is to take the other party into your confidence, the last three for both classes are to avoid unreasonable exactions, to co-operate and to "keep the cars moving." The last is the ultimate end. It can be reached if the right spirit is developed.

Chicago Clearing Yard

ANY shipper or railroad operating official familiar with the congested freight facilities in Chicago, and the resultant high cost of operation, realizes the urgent need of relief. Twelve of the railroads entering the city think they have found the key to the situation in the rejuvenation of the "Clearing Yards," as described on page 295. Others have held back, pointing to the failure years ago of the Chicago Union Transfer Railway. They doubt the efficiency of yard units so much larger than anything heretofore tried, and serving strongly competitive interests. The failure of the original project need not be taken too seriously; the switchback movement required was alone sufficient to damn it, as a progressive forward movement is essential to the successful operation of large yards. Other errors in the original design have been rectified in the new. Above all, the joint ownership of the operating company makes it certain that the yard will not have to beg for business. It will handle either through trains direct from the road, or interchange trains made up at other yards in the city. Its experiences will be carefully awaited by all operating officials.

Wood Preservative Situation

IT was pointed out in this journal last week that the shortage of creosote oil, due to the war, would influence the wood-paving-block industry. Preservative work generally will be affected and relief is to be expected by reducing the amount of oil used per cubic foot of timber and by the adoption of other preservative materials. Even then renewals will probably be made in considerable amounts with untreated timber, while other renewals will be postponed until the shortage is relieved. It has been reported that England has lifted the embargo on the export of creosote oil, a move that will afford partial relief. The total consumption of creosote oil in the United States in 1913 was about 100,000,000 gal., of which about 40 per cent was produced here. In the case of wood blocks for paving, the time is now opportune for reducing the impregnation. A reduction has been frequently urged by American specialists and is supported by European precedent. The present shortage may bring about a change where argument has been unavailing. True, there has been a tendency toward a reduction during the past few years. It is questionable, of course, whether under the severe climatic and service conditions in American cities a reduction of treatment to the 10 or 12-lb. average prevailing in English cities would be advisable, but a reduction of treatment to 15 or 16 lb. per cubic foot, accompanied by the use of a good grade of pitch filler, is advisable. As to a substitute for creosote at least one company will temporarily use zinc chloride. On account of the present conditions the probable life of a given timber under given conditions, as against the first cost and the charges, such as labor and delays, incidental to replacements, must be compared anew for timber untreated and preserved with different materials. As to creosote, the comparison should be made with a lighter impregnation than has been customary in the past.

Twelve Years' Work

IN this issue will be found a summary of the operations of the U. S. Reclamation Service from its institution in 1902 to the end of the 1913 and the 1914 fiscal years. While the activities of the Service are quite well known to American engineers, such a summary as this will be a revelation to all except those whose work has required them to follow closely the operations of this branch of the Government's activities. Surprise will be caused not only by the tremendous quantities involved, but also by the variety of work. Most notable is the fact that 113,000,000 cu. yd. of earth, indurated material and rock have been moved, an amount which compares well with some of the tremendous yardages on the Panama Canal. Quantities equally as interesting in their respective lines will be found scattered through the table. As to scope of work few are aware that 39,000 tons of coal have been mined and that the steel bridges aggregate over 5000 linear feet. Such data are particularly interesting at the present time when Congress has under consideration an amendment which will upset the plan under which this tremendous amount of work has been done. Heretofore, the Secretary of the Interior and the director of the Reclamation Service have apportioned the moneys, which have automatically come to the reclamation fund through public land sales, to the various projects in accordance with the needs. Now Congress will say, if the amendment is accepted by the Senate, on what projects money is to be spent. Friends of efficient administration still hope that the present methods will be continued.

Economic Design of Penstocks

THE economic diameter of pipes is a problem entering into the design not only of hydroelectric plants but of most works using water on a considerable scale. The problem has from time to time been discussed in this journal, and on page 300 of this issue will be found a contribution on the subject by Prof. Melvin L. Enger. He considers the problem as applied only to steel penstocks, but his formulæ can, with slight changes, be applied to other materials, such as wood or concrete. For concrete, for instance, n, which represents the percentage of over-weight due to laps, cover-plates, etc., and w, which is the weight of 1 cu. ft. of steel in the penstock, can be omitted, while a, which is the cost of steel in dollars per pound, would become the cost per cubic foot of reinforced concrete. In a concrete tube the thickness t is so large that it must be considered and the volume of a section 1 ft. long would, therefore, be $\pi t \ (d + t)/144$ and the annual cost, $C = 0.0218art(d + t)$ dollars. Equations (2) and (3), referring to horsepower used in overcoming frictional resistances and its annual value, will remain unchanged, while equation (4), due to the changes in equation (1), will read $d = 10.98[Eb(Q^3_1z_1 + Q^3_2z_2 + \text{etc.}) \div artc^2]^{1/6}$ This will give the value of d when the thickness t is known. The value of t must be selected with reference to the head in order that the pipe may be waterproof.

Another point to be observed is that the transverse reinforcement must be sufficient to resist the tension in the section; in other words, this reinforcement can be considered as a fictitious steel pipe, and as such the equations in Professor Enger's paper are directly applicable to it. This will give another diameter, slightly different from that arrived at when the concrete was considered, and the designer can choose any suitable dimension between these limits, knowing that he approximates as nearly as possible the most economical diameter for the pipe in question.

Woman's Aid in the Road Movement

WHILE there have been notes in daily papers the country over regarding the formation of the woman's department of the American Highway Association, its importance has generally escaped the attention of the newspaper editorial writers. Few moves in the history of highway promotion in this country can be compared with it as to the probable opportunities. Throughout the world women have been displaying for the last score of years a new energy. It has shown itself most strikingly in the suffrage movement, which is active not only in England and the United States but in Continental European countries as well. Even in India, reports come, women are demanding a new place in the country's activities. Their influence in welfare work has been very marked.

At bottom these activities are the indication of a tremendous energy, which will be spent somehow, by ways not always commendable and useful if repression is tried. What could be wiser, then, than to attempt to direct this force into profitable channels? That, basically, is what the American Highway Association is doing—affording a new outlet for that tremendous energy which the women of the country can furnish. It is certain that if the women of a community become thoroughly interested in road improvement and have available an organization by which they can secure action prompt improvement of the highways will assuredly follow.

That their interest is no less than that of the men is evident after brief consideration. The marketing of farm produce and rapid intercourse between nearby communities are the affairs of men; the development of the minds and souls of the little folks on the farms is the chief care of the women. Certainly the latter is more important than the economical marketing of the season's crop of corn or of a carload of beeves. That it is dependent on the condition of the roads needs no demonstration. Furthermore, farm isolation, due to the lack of communication with the outside world, in turn due to impassable roads, falls most heavily upon the women.

The first public evidence of the new work will be a conference during the American Road Congress at Atlanta, between women from widely scattered sections of the country, to consider ways and means of making the organized efforts of women most effective for the betterment of the public roads. Assurances have already been received that the meeting will be largely attended.

The movement instituted is probably destined to play a large part in highway promotion in the near future. The association has already demonstrated its ability to organize effectively and the same success is to be expected of the new work when it is well under way.

Sheerboards Versus Summit Pools in Hydraulic Dam Construction

HYDRAULICKING either for excavation or embankment construction is a factor of growing importance in engineering. A large work of this character, involving the moving of over 2,500,000 cu. yd. of material, as described in this issue, has developed some interesting features.

The work consisted of excavating material, and depositing part of it on the hillsides so as to form roadways and terraces, the part on low ground. Depositing material on a hillside so as to form slopes steeper than the existing slopes is an unusual undertaking. For this purpose it appears that gravel was mostly used, which facilitated the process. Slopes were formed with sheerboards, as is not unusual in hydraulic dam construction.

Banks were built without surface pool by allowing water to run lengthwise of the bank, constantly shifting the stream from place to place. This has been done before with sand. The use of this method with coarse gravel and sand so as to result in a thorough mixture, as was done at Portland, is believed to be novel in hydraulic bank construction, although it is but copying nature in its work of building gravel fans in valleys at the mouths of side creeks with steep gradients.

It is obvious that this method may have an important bearing on hydraulic dam construction and that excellent banks may be built in this manner with a mixture of sand and gravel, by constructing the dam from the ends, instead of from the bottom up and with a summit pool. It must be borne in mind, however, that the clay particles carried by the water are likely to be completely wasted with this method and that a bank thus built will probably not be tight. Leakage through a bank consisting of well graduated sand and gravel thoroughly mixed may not be a serious matter. If a really tight dam is desired, however, it remains to be proved that this manner of construction, without summit pool and without core, and with an almost complete loss of the contained clay can be used. The gravel terraces of the Portland work consist of well-mixed materials but they are not water tight and act as perfect underdrains, which, for their purpose, is a decided advantage as it adds to their stability.

The use of a summit pool will probably always be necessary where clay is to be handled and, in fact, was for that reason compulsory on part of the Portland work for a fill at an elevation above the gravel deposits. The sloughing of about 400,000 gal. of material, half clay, half water, illustrates the slowness with which masses of water-deposited clay, even where thoroughly underdrained as in this case, are relieved of their surplus water. It again emphasizes the precautions which are essential in using clay in hydraulic dam construction.

All in all the work is a most interesting one and is a tribute to the imagination and courage of those who conceived it. Their participation in the extraordinary "regrade" work in Seattle fitted them admirably for undertaking the novel task of hydraulicking a hillside into a terraced residential park.

Industrial Service Work—An Opportunity for Engineering Societies

AT the spring meeting of the American Society of Mechanical Engineers in St. Paul, Prof. Joseph W. Roe, of Sheffield Scientific School, described the industrial service work which has been carried on at that institution since the college year of 1907-1908. The paper, with discussions, has now appeared in the September number of the "Journal" of the society. The movement described is important because of the opportunities it holds forth for the student to round out his education, by developing sympathy with those less fortunate than himself, and the good that it may do for the laborers who can be reached. Furthermore, it offers a form of activity that is likely to be welcomed by some of the younger, enthusiastic men in both local engineering societies and branches of national organizations.

Briefly, the plan consists in having Sheffield students who are so inclined bring together small groups of foreigners for instruction in English, elementary mathematics, drawing and other elementary studies. English is the greatest need and is the most common of the subjects taught. Without a knowledge of our language the foreigner cannot get a job alone, cannot buy his own supplies to advantage, cannot understand instructions for his own work and his own personal safety. For these reasons we have the padrone and the labor contractor.

It is unnecessary to enlarge upon the benefits to the recipients of the instruction. Nor is it necessary to say much as to the benefits to the student—temporarily become teacher—who has sufficient interest in his fellowmen to give up some leisure for their improvement. One of the disadvantages of modern college life is the exaggerated idea which it is apt to give the student of his own importance and his superiority over those who are unlearned, or uncultured, or both. With the most brilliant of abilities these handicaps often doom a man to failure. The intimacy acquired with laborers in an effort to teach them to read, to figure or to draw breaks down the barrier, discloses to the young man the human, sympathetic, aspiring character of the man in the ditch or the mine and gives him a new angle from which to appraise the management problems he will meet as a future executive.

Since being started at Yale the movement has spread to other institutions and there are now about 3000 students engaged in the work, reaching about 50,000 workmen. This rapid extension indicates not only that the advantages of the work are appreciated, but that we have coming forward in our technical colleges a fine class of young men, well equipped in knowledge of their fellowmen for the executive work of the future.

There is every reason why the plan should be extended beyond the confines of the technical colleges. In fact, Professor Roe himself advocated that this activity be taken up by the student branches of the American Society of Mechanical Engineers. If that should be done, it is inevitable that the local branches of the society will become interested in the work and thus bring the powerful influence of the whole organization to bear upon the extension of the plan. Other national organizations may well consider its possibilities and local engineering societies probably have in their membership a great many young men who, shortly after graduation, would welcome such an outlet for their superabundant energies. One who has followed the development of our local engineering societies in recent years cannot but admire their enthusiasm and energy. Many of them are doing splendid work, not merely in a selfish way—for the benefit of their own members—but for their communities. They are in a position to make their cities and states still more their debtors by engaging in industrial service work.

Personal Liability for Fires

A CASE now before the courts of the State of New York opens up some new and important questions regarding responsibility for fires. Whatever the decision may be the subject is now fairly up for discussion and legislation. The immediate issue is the responsibility of the owners of a building for damages due to their non-compliance with an order of the Bureau of Fire Prevention of New York City that sprinklers be installed. The fire commissioner brought suit to recover the cost of putting out a very disastrous resulting fire and the question is now before the court. It has been the custom of owners of buildings to flout the fire departments, city governments and others in authority in the matter of proper protection against fires. Millions of dollars of property and hundreds of lives have been sacrificed in the last few years merely because the owner would not go to the expense of suitable provision against the dangers of fires. The large loss of life in a single factory loft in New York City and a dozen others in hotels and apartments bear witness to the carelessness of the average owner. Furthermore the administration of justice is so deliberately intended to favor the criminal at every point that instead of serving a long term in the penitentiary for criminal negligence amounting to manslaughter, the guilty party invariably escapes and usually is successful in dodging civil proceedings as well.

In some foreign countries there is a very direct responsibility for damage by fire owing to negligence and one of the crying needs in our own country is the passage of such legislation as will leave no loop-hole for the guilty. The real root of the matter runs, however, deeper than this. It penetrates down to the very imperfect conception of ethics which characterizes the legal provisions against infringing the rights of others. There is a beautiful inconsistency in the legal attitude regarding infringement of property and other rights. One may not, for example, knock down his neighbor and take his pocketbook without some risk, at least, of repenting it behind the bars. One may, however, so use his property as to irremediably damage his neighbor's to the extent of thousands of dollars, and go scot-free on the plea that he is merely doing as he pleases with his own property. A big garage may be built in a residential section, producing an added fire risk which means the payment of higher insurance premiums on the part of the residents. Yet if the garage owner has succeeded by pull or bribery in getting a permit, all too easily obtained at best, he may inflict the direct damage of added fire risk and the greater indirect damages due to foul smells and noises at all hours of the day and night without, apparently, the slightest liability. A man may devote his house to such uses as will depreciate the value of the property immediately around him by 25 per cent and he cannot, in our semi-barbarous view of property rights, be reached by the arm of the law. Only in a few cases, drawn along very narrow lines, is the principle that one may not use his own property so as to damage his neighbor's without incurring responsibility, recognized.

It is the failure to grasp these fundamentals of decent ethics and to embody them in law which is responsible for a great part of the fire damage. If the responsible owners of a building were liable to a term in jail for not equipping their property as directed by the authorities to avoid fire risk and the statute were in such terms that the only question to be determined should be the fact as to whether the work had or had not been done, there would be small loss of property and less loss of life owing to imperfectly equipped buildings. If the owner of a fire-trap were liable to his neighbors for any increase in insurance rates which he might bring upon them, and in the last resort for any damage that fire originating in his premises might do, the erection of fire-traps would be stopped very promptly and those now existing would be demolished.

Our laws make individual property a fetish, and only very imperfectly and in limited instances recognize the fact that the community in which a man lives has such an equity in his tangible property, as part of the community organization, that he has no right to use it to others' detriment. Many foreign countries are far ahead of the United States in the recognition of these mutual rights of society. If some of the legislation derived by them from long experience could be put into force here the annual losses of property and life from fire would be greatly lessened.

The issue which has been raised in New York will have to be decided on the merits of our very imperfect laws relating to public safety. Whatever the ultimate decision may be, it should lead to an immediate strengthening of these laws, particularly with reference to putting them in such form as to leave the jury before whom future cases might be tried no room for sympathetic doubt once the facts are shown.

Westover Terrace Project in Portland, Oregon

Sluicing 3,000,000 Yards of Material from a Steep Hillside in Order to Construct a Terraced Residential District and Convert an Existing Lake into an Industrial Section

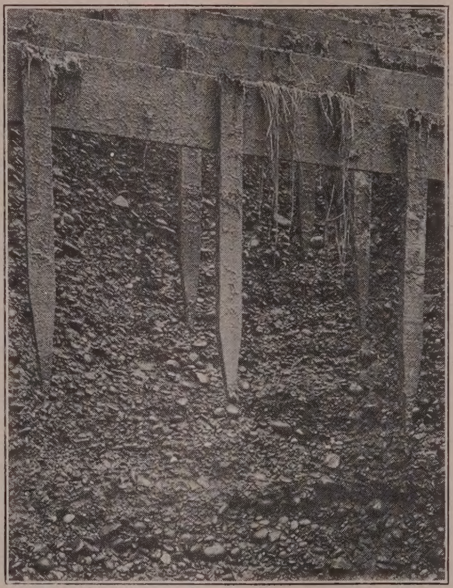
By R. M. OVERSTREET
Portland, Oregon

THE large hydraulic excavation project being carried on by the Lewis-Wiley Hydraulic Company, in Portland, Ore., and known as Westover Terraces, consists in the reduction of a portion of the inaccessible hillside on the west side of Portland to a parked residence district and the filling of a portion of the overflowed lowland along the Willamette River, known as Guilds Lake, to railroad level and its platting into tracts for industrial enterprises with railroad connections. The project is the conception of Charles S. Wiley and William H. Lewis, who, under the firm name of Lewis & Wiley, Inc., had handled large sluicing contracts in Seattle and who had determined to find a location where they could secure a tract of land to improve in this manner and derive the benefit of the increased land values created by the improvement. They secured the Portland property in 1909. The whole project embraces several tracts on the west side of Portland, the upland portion of it adjoining one of the best residential districts. The improvement covers a total of 142 acres, 41 acres of which lie in Guilds Lake, a shallow body of water adjoining the Willamette River; 36 acres are in a gulch running back into the hills from the lake, and the remaining 65 acres are upland rising to a maximum elevation of 675 ft. above low water in the river.

General suggestive plans for the layout of the property were made by Olmsted Brothers, of Brookline, Mass., but these have been changed from time to time to suit conditions, although the general scheme has been carried out. The streets have a maximum gradient of 8 per cent, with the exception of one or two instances, where grades are increased to 14 per cent on lateral branches. The main boulevard, 60 ft. in width, runs from the toe of the hill to the summit in a serpentine on an 8-per cent grade. The lateral streets branch from the main boulevard to the boundary lines of the property. Owing to the constant ascent to the summit and the doubling back and forth of the main boulevard, the difference in elevation between the lower and upper sides of the blocks is in some cases as high as 90 ft. This difference in elevation is taken up by the construction of terraces.

CHARACTER OF MATERIAL

The carving of this scenic residential district out of the inaccessible hillside has been a tremendous task and the work ranks as one of the largest pieces of hydraulic excavation in the country and has attracted attention of engineers from all localities. The estimated quantity in the original plan was 3,310,000 cu. yd., but changes made since that time have reduced the estimate of earthwork to 2,854,000 cu. yd. To April 1, 1914, 2,572,000 cu. yd., or 90 per cent of the total, had been moved. The materials composing the hill are clay and gravel in proportion of 35 per cent clay, or 1,000,000 cu. yd., and 65 per cent, or 1,855,000 cu. yd. of gravel. The gravel was overlaid with a top soil of from 6 to 20 ft. of clay, but no gravel was encountered above an elevation of 456 ft. above the river. Had the gravel and clay been intermixed, the carrying capacity of the water would have been greater and the construction of the terrace fills would have been greatly simplified.



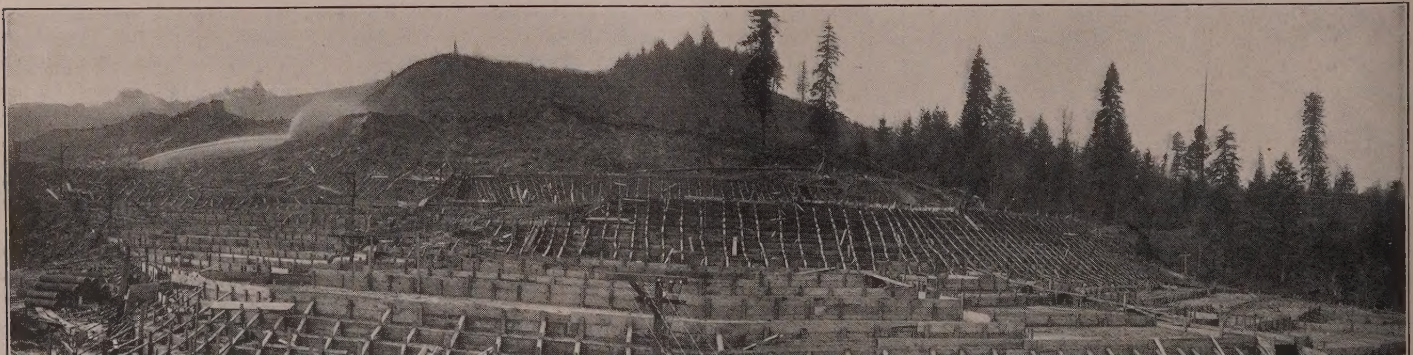
FORMATION OF GRAVEL EMBANKMENT IN WASHED-OUT POCKET

PUMPING PLANT

Actual work on the improvement was started in April, 1910, and it has been prosecuted night and day since that time with the exception of a shutdown of 14 months from September, 1912, to November, 1913. The original plant installation consisted of a pumping plant located on the lake tract with necessary flumes and pipe lines. This plant consisted of four 10-in. five-stage Worthington centrifugal pumps direct-connected in units of two each to two 650-hp two-phase, 60-cycle, 2000-volt Westinghouse motors with a 25 per cent continuous overload capacity. The guaranteed efficiency of the motors was 90 per cent and of the pumps 70 per cent, making a combined plant efficiency of 63 per cent. The pumps were designed to deliver 8400 gal. per minute under 375-ft. head at 690 r.p.m. This plant [described in the Engineering Record of May 16, 1908, page 637] had given twenty months' service in the Jackson Street regrade in Seattle before it was installed in Portland. The center line of the pump shaft was located at El. 25, and as the fill on the lake tract was to be made to El. 34 it was necessary to construct a covered intake box from the pump house to a point outside the area to be filled.

TRESTLE AND FLUME

Excavation started at El. 240 at an existing platted road around the base of the hill and the material was carried to the



METHOD OF BUILDING WESTOVER TERRACES BY MEANS OF SHEERBOARDS AND SLUICING dump in the lake in a 6-per cent flume supported on a timber trestle crossing streets and private property and having a maximum height of 75 ft. and a total length of 2500 ft. The trestle carried the 6-per cent flume on top. A temporary flume on a 9-per cent grade was bracketed to the side and used for making a fill of about 300,000 cu. yd. about half way between the cut and the lake tract. The water lines from the pump house to the giants were also hung on this trestle. The 6-per cent flume was divided into two channels by a bulkhead. One side of this was lined with 4 x 4 x 8-in. blocks laid with the grain up and the other side with ¾-in. white iron plates, 21 x 34 in. in dimension and weighing about 140 lb. each.

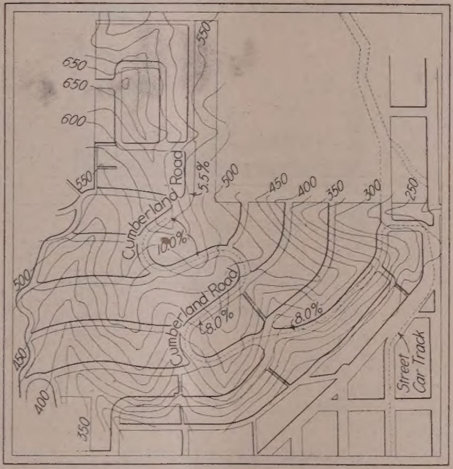
The cost of construction of the trestle and flume, not including the lining, was $24.20 per 1000 ft. b. m., of which $9.08 was for labor, $2.12 for iron and nails, and $13 per 1000 ft. b. m. for lumber, or about $6.75 per foot. Iron plates cost from 1¾ to 2¼ cents per pound.

CARRYING CAPACITY OF IRON PLATES

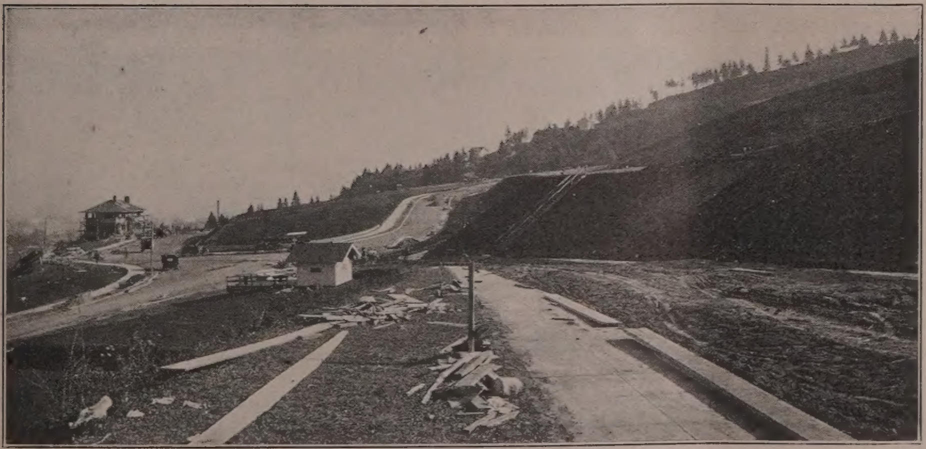
The carrying capacity of the iron plates was very satisfactory as compared to the wood blocks. The average wear on the wood blocks on a 6-per cent grade, working in gravel, was found to be 125,000 to 150,000 cu. yd., while with the plates it was possible to carry 1,000,000 to 1,200,000 cu. yd. With the block lining it was found necessary to replace blocks about every five weeks, which would have occasioned considerable loss of time had it not been for the extra flume. It was found that the gravel running over the steel plates made so much noise that residents in the vicinity complained of being unable to sleep at night, so the steel-lined flume was used during daylight hours and the wood-lined side at night. Wear of blocks in clay was found to be about 1,000,000 cu. yd.

Owing to the large percentage of gravel in the hill it was decided to build gravel bunkers at the end of the flume and to wash gravel for commercial purposes. This was done for several months after the start of the work; but it was found that the screening of the gravel so cut down the possible output of the excavation in the pit as to materially increase the time element in the work, so the gravel business was discontinued and all material was dumped into the lake for filling.

THIS TERRACE WITHSTOOD OVERFLOW OF 200,000 GALLONS OF WATER AND MUD



HILLSIDE TOPOGRAPHY AND ROADS



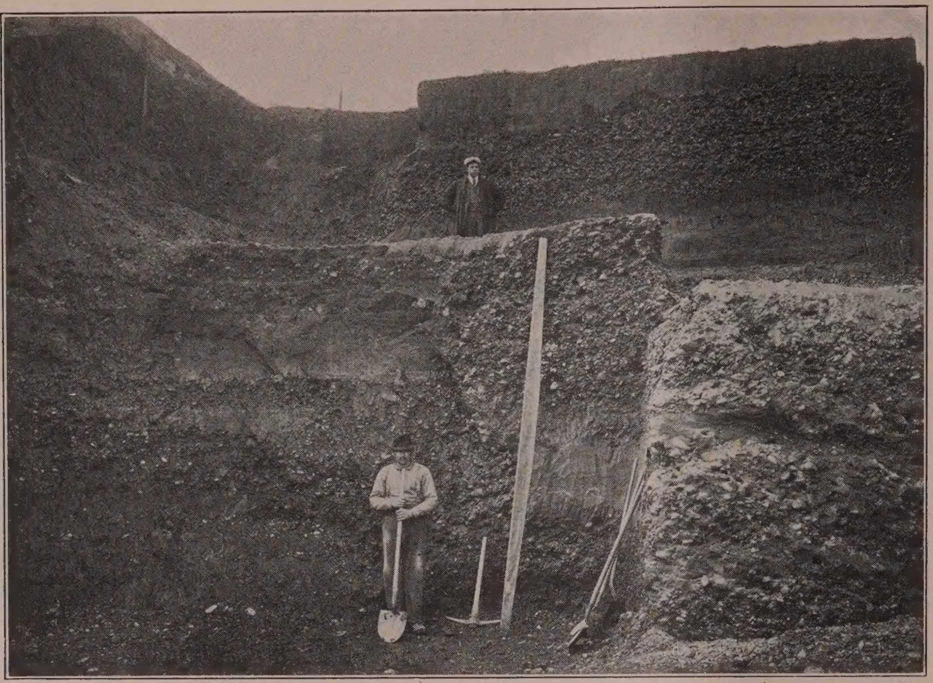
VIEW OF WESTOVER TERRACE PROJECT PARTLY COMPLETED

As excavation progressed into the hill the flume and water lines were carried up generally on the line of the main street with the flow line of the flume about 2 ft. below the established grade of the street. The difference in elevation between lower and upper streets was taken care of by the construction of terraces. Where the difference in elevation between upper and lower sides of a block was 48 ft. or less the difference was divided into two equal terraces—one at the front of the block and one at the center line. Where the difference of elevation exceeded 48 ft. the lower terraces were constructed to a height of 24 ft. and the remainder taken up in the terrace at the center line of the block. The excavation on the private property was all made below finished grade and the terraces were then backfilled to true grade with material from above. In this way the terraces are all carried up on true line and grade with very little hand work.

SHEERBOARDS FOR TERRACES

The method of building the terraces is known as the sheerboard construction and is well adapted to the building of dams and all fills of a hydraulic nature. The slopes are carried up by a series of small bulkheads or sheerboards made of two 1 x 12-in. pieces nailed one above the other to 2 x 4-in. stakes 6 to 7 ft. long, spaced about 4 ft. center to center and driven into the ground and the growing embankment. The first row of sheerboards is placed at the line of intersection of the slope with the ground; the second, third and subsequent rows of sheerboards are placed as the embankment rises, each line being spaced according to the designed slope. Slopes on this work were 1½ to 1. The bottom of each sheerboard is placed from 2 to 10 in. below the top of the upper board in the preceding bulkhead, depending on the nature of the material of which the embankment is being made. In gravel, for instance, the seal is less than is required for making a fill of fine clay. In the lighter and finer soils it is necessary to brace between the stakes as shown in the detail section. After depositing its load the water is taken off the fill through spillways, which are located at convenient points. These consist merely of flumes running down the slope through the sheerboards. By this method the mass of the embankment is continually drained as the fill is deposited and when the fill is completed it is as compact and substantial as though it were in the original bank. The amount of lumber required for the sheerboards can be obtained from the data in Table 1.

When the giants were working in gravel the bank was undermined by pressure from the jet without the use of powder. In clay the pressure of the stream had little effect on the bank and it was necessary to shoot the material in order to run any sort of a load with the water. A powder crew consisting of eight men was employed on the day shift to keep the material broken up in front of the giant. By alternating giants



EXCAVATION FOR BASEMENT DISCLOSES NATURE OF EARTHFILL

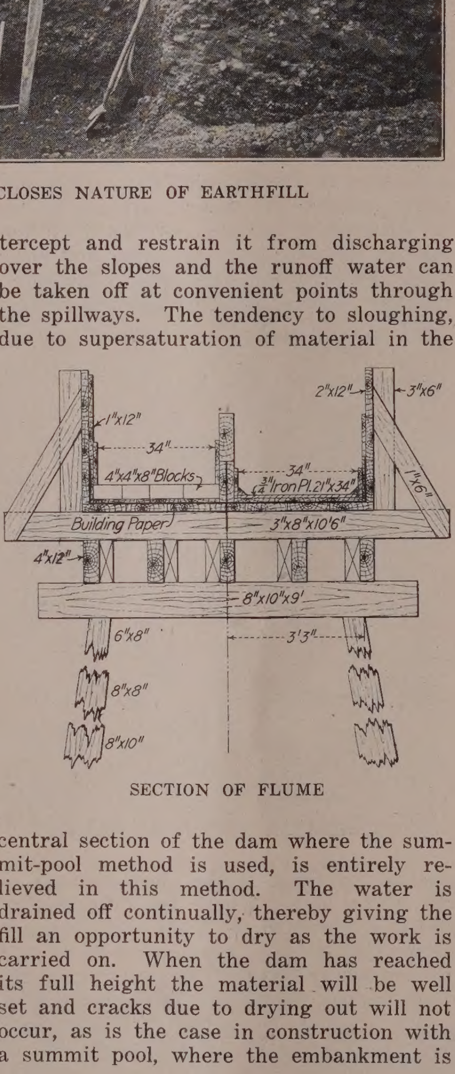
from one shift to another it was possible to keep the clay well broken up for a full day's run. A stumping powder of 20 per cent strength was used in charges of from three to seven sticks, and from 400 to 700 lb. were used daily. Powder cost $176 per ton delivered on the work; fuse, $4.50 per 1000 ft.; and caps, $9.80 per thousand.

When the completed embankment has had time to drain and take a set the upper board of each sheerboard line is taken out, the stakes cut off and the fill is rattled down to a true line, raked and seeded to grass.

Some idea of the solidity of these fills may be gained from the accompanying photographs. One view shows a terrace 70 ft. high which was constructed during June and July, 1912. Owing to a slump out of two terraces which were being constructed above it about 200,000 gal. of water and mud rushed down over this slope on Feb. 10, 1914. The only damage done was the cutting off of the grass and the washing out of a small pocket of about 40 cu. yd. of gravel. A view shows the lower 1 x 12-in. piece which is left in the embankment. Another view shows the pocket which was washed out. The depth of the hole in the back was about 16 ft. It is standing vertically, and the illustration gives a very good idea of the condition of these fills. A third picture shows an excavation being made for a basement in one of the fills in May, 1913. This fill was placed in 1911. The clay and gravel strata can be distinguished very plainly as they were washed in.

Sheerboards Applicable to Dams

The value of the application of the sheerboard method of building hydraulic embankments to the construction of earth dams has recently been recognized by the Ambursen Company of New York, which has formed an agreement of association with Lewis, Wiley & Morse, of Seattle, for the carrying on of such construction. In the sheerboard method of constructing slopes no summit ponds are used. The sluiced material can be admitted at one or both ends of the dam and allowed to flow longitudinally across it with a perfectly free discharge. The sheerboards will intercept and restrain it from discharging over the slopes and the runoff water can be taken off at convenient points through the spillways. The tendency to sloughing, due to supersaturation of material in the central section of the dam where the summit-pool method is used, is entirely relieved in this method. The water is drained off continually, thereby giving the fill an opportunity to dry as the work is carried on. When the dam has reached its full height the material will be well set and cracks due to drying out will not occur, as is the case in construction with a summit pool, where the embankment is never drained until the dam has reached its full height.



SECTION OF FLUME

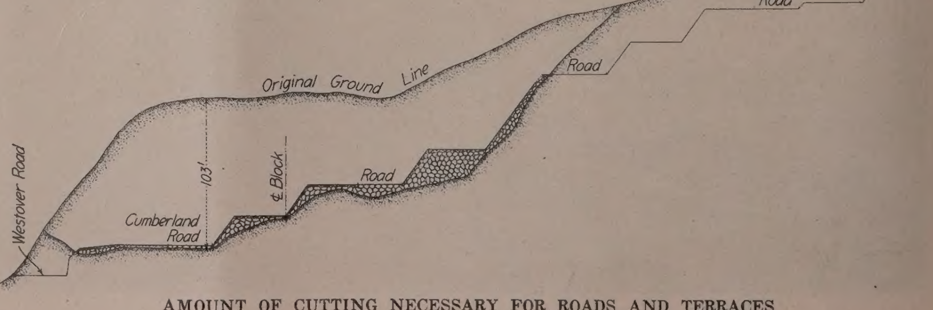
As the excavation progressed into the hill the pumping head was continually increasing, and consequently it became necessary to install an additional pump. The installation was made in October, 1910, and consisted of a 16-in. two-stage Worthington turbine pump, direct-connected to a 900-hp Westinghouse 2300-volt, 60-cycle, two-phase induction motor. The efficiency guarantee on the motor under full-load condition was 91 per cent. The pump was designed to deliver 8400 gal. per minute under a pumping head of 675 ft. with a head on the suction of 375 ft. from the five-stage pumps, leaving a resultant head of 300 ft. The efficiency guarantee on the pump was 71 per cent.

Tunnel Driven Through Hill

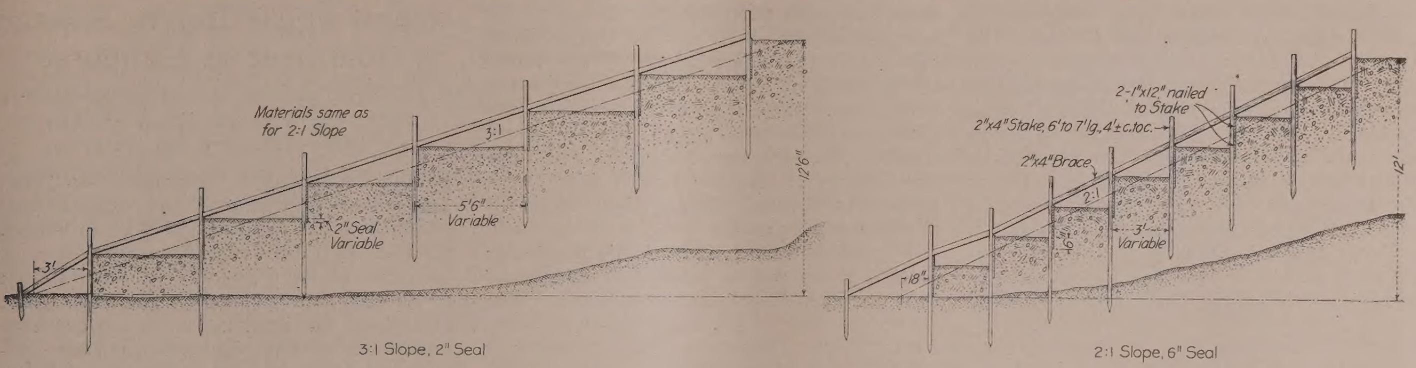
During June and July, 1911, a 5½ x 6-ft. tunnel was driven through the hill on the west of the property to carry material out to the gulch for filling. The tunnel was constructed on a 10-per cent grade through hard gravel. It was about 530 ft. long and cost $2.95 per linear foot. This flume was used in conjunction with the 6-per cent main flume until September, 1912, when the 6-per cent flume was torn down. Since that time all material has been delivered through the tunnel and down the gulch to the lake property. Some filling was done in the gulch, but there was not enough material in the hill to fill it and the lake tract. The tunnel was extended up through the property from the original portal by constructing the covered box on ground as excavated. When terraces were backfilled the box was covered over and when work is completed the tunnel will be plugged and filled with earth sluiced into it.

When running in the gravel material the flumes at the discharge end had to be extended every few days, as the gravel would pile up and not spread around, and it was necessary to level off the gravel fill with steam shovel and cars. When running in clay the material would flow for 800 to 1000 ft., making a fill as level as a table. Several industrial buildings have been constructed on the gravel fill with no subfoundation of either piling or piers, and no settlement or cracking has occurred, which demonstrates the solidity of these fills.

At the time of starting work again in November, 1913, the pumping plant was entirely rearranged. One group of two 10-in. pumps with motor had been taken to another piece of work after the shut down in 1912, which left two 10-in. pumps and the 16-in. two-stage pump to carry on the work. The 16-in. pump was taken to a point on the hill west of the improvement and set at El. 326 to act as a booster in the line. The



AMOUNT OF CUTTING NECESSARY FOR ROADS AND TERRACES



3:1 Slope, 2" Seal

2:1 Slope, 6" Seal

ARRANGEMENT OF SHEERBOARDS FOR 3:1 AND 2:1 SLOPES MADE BY HYDRAULIC SLUICING METHCD

discharge from the lower pumps is through two lines of 18-in. wood-stave pipe for a length of 1500 ft. and from here in a 24-in. pipe to the booster. From the booster there are two 18-in. lines for a distance of 400 ft., converging into a 24-in. line, 300 ft. long, leading to a plug. From this point the 14-in. supply lines are taken off to the giants. Two giants are connected up, but only one is used at a time, so that it is not necessary to shut down in order to move the giants. A record of the location and elevation of the giants is kept and the pressure is taken on each giant once every 8 hr. shift, and the discharge is computed from these pressures. The working pressure at the nozzle varies from 50 to 80 lb., according to the elevation of the giant and size of the tip.

PLANT

The existing plant installation now consists of one 650-hp motor direct-connected to two 10-in. five-stage Worthington pumps situated on the lake tract at El. 25 and a 16-in. two-stage Worthington pump direct-connected to a 900-hp Worthington motor situated on the hill adjoining the work at El. 326, making a total connected load of 1550 hp. The plant is now delivering 5,850,000 gal. of water per 24 hr. against a total head of 745 ft. with an efficiency of about 49.3 per cent. This low efficiency is due to the throttling of the booster pump, which is designed to deliver 8400 gal. per minute (12,000,000 gal. per day) under 675-ft. head, with 375 ft. on the suction. Under actual conditions the pump is only delivering about half the designed discharge under a 425-ft. head with 46 ft. on the suction, leaving a resultant head of 379 ft. It was intended to bring back the other unit of two 10-in. pumps for the lake plant, but as the work was so far advanced when the unit was at disposal it was decided to run through with the present installation.

After work was resumed in November, 1913, following the 14 months' shut down, the material was all run through an open-box flume on a 10-per cent grade through the tunnel mentioned in the foregoing and on down the gulch on the trestle for a distance of 2250 ft. Here it runs into a 20-in. wood-stave-pipe line to the lake tract, a distance of about 2000 ft.

TABLE 1—LUMBER REQUIRED FOR SHEERBOARDS

Depth of seal, in.	Feet, board measure
2	1.09 × area of vertical projection*
4	1.20 × area of vertical projection
6	1.33 × area of vertical projection
8	1.50 × area of vertical projection
10	1.71 × area of vertical projection
12	2.00 × area of vertical projection
Stakes and bracing	1.50 × area of vertical projection

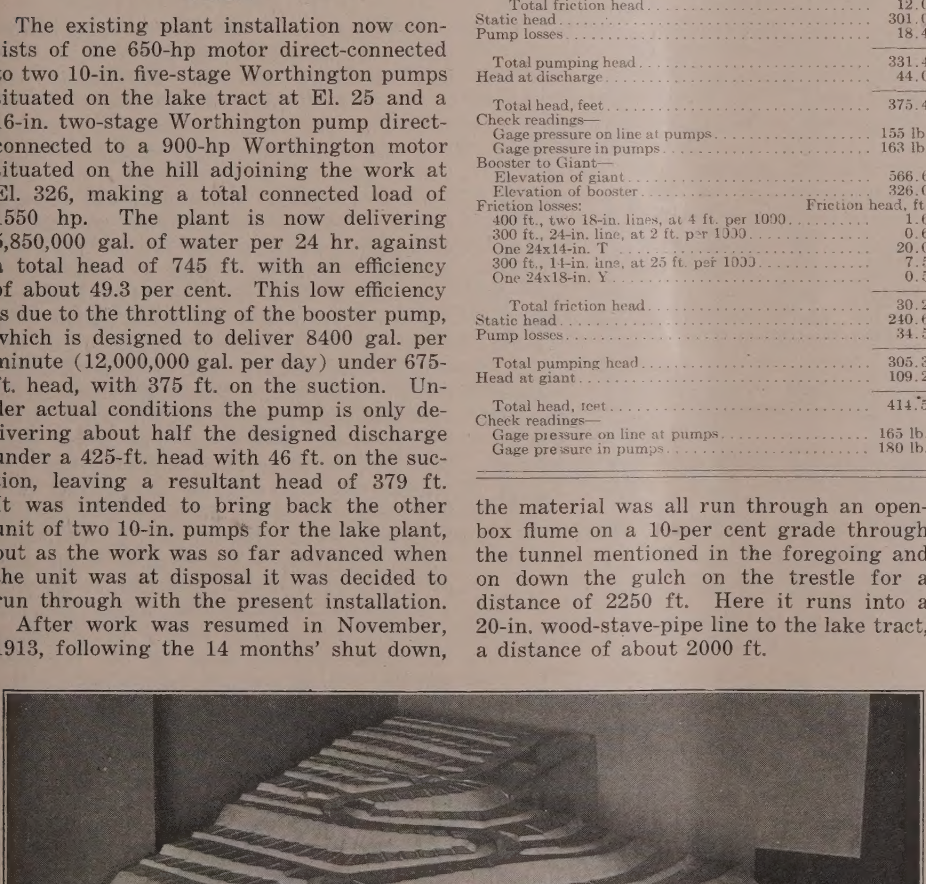
Add 10 per cent for loss due to lap, waste, etc., on 1 × 12-in. lumber.

*Vertical projection of slope.

TABLE 2—DIVISION OF HEAD FOR PRESSURE WATER UNDER WORKING CONDITIONS

Discharge, 4062 gal. per minute. Check readings April 16, 1914

Lower Pumps to Booster:	
Elevation of lower pumps	25.0
Elevation of booster pumps	326.0
Friction losses—	Friction head, ft.
1500 ft., two 18-in. lines, at 4 ft. per 1000	6.0
1500 ft., 24-in. line, at 2 ft. per 1000	3.0
One 90-deg. angle	2.0
Two 24x18-in. Ys	1.0
Total friction head	12.0
Static head	301.0
Pump losses	18.4
Total pumping head	331.4
Head at discharge	44.0
Total head, feet	375.4
Check readings—	
Gage pressure on line at pumps	155 lb.
Gage pressure in pumps	163 lb.
Booster to Giant—	
Elevation of giant	566.6
Elevation of booster	326.0
Friction losses:	Friction head, ft.
400 ft., two 18-in. lines, at 4 ft. per 1000	1.6
300 ft., 24-in. line, at 2 ft. per 1000	0.6
One 24x14-in. T	20.0
300 ft., 14-in. line, at 25 ft. per 1000	7.5
One 24x18-in. Y	0.5
Total friction head	30.2
Static head	240.6
Pump losses	34.5
Total pumping head	305.3
Head at giant	109.2
Total head, feet	414.5
Check readings—	
Gage pressure on line at pumps	165 lb.
Gage pressure in pumps	180 lb.



PLASTER MODEL OF WESTOVER TERRACE PROJECT

A tract of about 6 acres of the upland property is in the head of a gulch or ravine, and it was necessary to make a fill here in order to connect the streets to existing platted streets on the hill across the gulch. About 408,000 cu. yd. are required to make this fill; of this amount 110,000 cu. yd. were in place Feb. 10, 1914, when there occurred a small slump out of two terraces which were being constructed in the gulch simultaneously. Owing to the fact that all material remaining to be excavated on the hill was required to make the fill in this gulch and also several small embankment areas it was necessary to hold all material on the upland and to discontinue filling on the lake tract. The material left in the hill after the shutdown in September, 1912, was all clay, the gravel strata running out when excavation reached a point above El. 456. The area of the gulch was small, the width across the top being slightly less than 300 ft., and in running the entire load of about 4000 cu. yd. daily into this fill the embankments were increased in height at the rate of about 2 ft. per day, and with the light clay material a condition of supersaturation arose.

The two terraces were being constructed at the same time by lateral flumes from the main box on the side of the gulch, the lower terrace varying in height from 18 to 30 ft., the upper from 18 to 25 ft. Owing to the conditions imposed, an attempt was made to keep a small summit pool (less than an acre in area) on top of the upper terrace, with the idea of saving as much of the material as possible. The strain was too much for the lower terraces of light clay and distortion of the sheerboards was noticed and warning given to proceed with the fill more slowly. The sheerboards were braced solidly with 6 x 8-in. timbers, but during the night shift on Feb. 9 the bulkhead gave way, allowing the water in the pool to run out through a break over the large embankment previously mentioned. It is estimated that about 200,000 gal. of water got away, carrying with it about 1000 cu. yd. of mud. This was carried down over the residential section below the hill, and the streets were covered with mud for an area of about twenty-five blocks. Several basements filled with mud and water and a section of Belgian block gutter was torn out, the blocks being carried down the street and piled up as though they had been chips of wood.

The fill was allowed to drain for several weeks and then three rows of piling were driven at the toe of the lower terrace. These were securely braced and boarded and the fill started again with a stream from a small giant with a 2-in. nozzle. With the piling reinforcement in the toe and the decrease in rapidity of building the fills it was believed that no more trouble would be encountered. Had there been some gravel with which to stiffen the terraces the trouble would never have occurred. On April 1, however, a small but perceptible movement of the fill was noticed, and owing to the uncertainty of the manner in which the mass would act when the large additional fill as planned was put upon it, it was decided to stop filling and change the plans so as to eliminate practically all filling.

From Table 4, showing the monthly excavation, it will be seen that the percentage of spoil carried varies from 4.82 to 17.8 per cent, with an average of 9.4 per cent to the end of March, 1914. Table 2 shows the division of head for pressure water under working conditions, and Table 3 the cost of pumping.

TABLE 3—COST OF PUMPING WATER, WESTOVER TERRACE PROJECT

	Mill. gal. pumped	Power, total	Cost, mill. gal.	OPERATORS		SUPPLIES, COOLING WATER, REPAIRS, OIL, ETC.		Total cost per mill. gal.	Gal. pumped per kw-hr.	Average pumping head, ft.
1910				Total	Mill. gal.	Total	Mill. gal.			
June	139.43	4022.17	$28.84	$387.00	2.77	138.57	.99	$32.60	207	377
July	130.00	3169.28	24.38	270.70	2.08	62.32	.48	26.94	245	420
August	126.37	3109.26	24.60	279.40	2.21	109.26	.86	27.67	243	393
Sept	113.12	2822.22	24.94	290.00	2.56	59.39	.53	28.03	240	425
Oct	79.60	2013.48	25.30	290.00	3.64	202.92	2.55	31.49	236	430
Nov	103.22	2432.52	23.56	290.00	2.80	71.63	.69	27.05	254	445
1912										
May	172.00	4790.73	27.91	295.00	1.72	289.25	1.68	31.31	215	610
June	195.00	5669.53	29.07	295.00	1.51	529.26	2.71	33.29	206	614
July	214.66	6288.77	29.29	295.00	1.37	284.86	1.32	31.98	205	586
Aug	188.32	5758.52	30.57	295.00	1.56	587.76	3.12	35.25	196	609
1913										
Dec	142.887	3982.39	27.87	*515.00	3.60	70.70	.49	31.96	214	673
1914										
Jan	128.146	3745.08	29.22	*515.00	4.01	33.88	.26	33.49	205	696
Feb	101.786	3022.02	29.68	*515.00	5.05	58.51	.57	35.30	202	707
Mar	143.123	4186.33	29.25	*515.00	3.59	227.95	1.59	34.43	205	736

*Increased charge for operators due to separation of booster pump from main plant and consequent use of two operating crews.

This record is not complete for full period of construction. There is an apparent extraordinary expense for supplies, oil, etc., in some months due to large amount of cooling water for transformers, which was purchased from city supply and was in some cases as high as $200 per month.

TABLE 4—MONTHLY RECORD OF EXCAVATION, WESTOVER TERRACE PROJECT

	Cu. yd. moved	Water in mill. gal.	Per cent spoil	Kw-hr. consumed	Cost of power	Connected hp	Hours run	Hp consumed	Flume grades, per cent
1910									
April	11,400.0	132.00	5.53	810,130	$4860.69	1300	168	1508	6
May	36,500.0						548		
June	49,790.0	139.43	7.14	671,050	4026.30	1300	600	1488	6
July	37,800.0	130.85	5.78	528,630	3171.78	1300	538½	1308	6
Aug	32,170.0	126.37	5.14	518,210	3109.26	1300	551½	1252	6
Sept	27,700.0	113.12	4.92	471,245	2827.47	1300	508	1236	6
Oct	33,370.0	79.60	7.53	336,036	2016.40	2200	204	2196	6 and 9
Nov	45,660.0	103.00	8.86	405,695	2434.17	2200	239	2252	6 and 9
Dec	64,680.0	109.74	11.78	426,730	2560.38	2200	247	2300	6 and 9
1911									
Jan	85,420.0	161.38	10.58	624,300	3745.80	2200	363	2292	6 and 9
Feb	80,980.0	188.59	8.33	817,400	4904.40	2200	478	2280	6 and 9
Mar	92,410.0	222.24	8.31	925,800	5554.80	2200	543	2272	6 and 9
Apr	125,400.0	224.05	11.19	913,800	5482.80	2200	542½	2245	6 and 9
May	101,820.0	246.00	8.33	1,044,000	6264.00	2200	627½	2217	6 and 9
June	78,190.0	247.97	6.40	1,033,200	6199.20	2200	625	2204	6 and 9
July	83,960.0	201.02	8.35	837,600	5025.60	2200	544	2052	6 and 10
Aug	104,160.0	208.73	9.98	869,700	5218.20	2200	577	2008	6 and 10
Sept	76,200.0	193.10	7.89	804,600	4827.60	2200	511	2096	6 and 10
Oct	91,351.0	185.67	9.84	773,700	4642.20	2200	534	1928	6 and 10
Nov.	69,670.0	33.52	10.00	139,668	838.08	2200	404	1917	6 and 10
Dec		105.90		441.252	2647.51				
1912									
Jan	89,592.0	191.03	9.40	795,884	4775.40	2200	492	2156	6 and 10
Feb	60,378.0	159.32	7.70	796,602	4784.40	2200	497½	2132	6 and 10
March	133,335.0	197.50	13.50	846.042	5065.20	2200	600	1880	6 and 10
April	103,667.0	211.10	9.80	959,754	5761.80	2200	615	2080	6 and 10
May	73,272.0	171.67	8.53	798,456	4768.20	2200	500	2128	6 and 10
June	103,800.0	194.77	10.70	944,922	5645.42	2200	594	2120	6 and 10
July	96,645.0	214.66	9.00	1,048,128	6271.80	2200	634	2204	6 and 10
Aug	105,242.0	188.32	11.20	959,754	5758.52	2200	603	2120	6 and 10
Sept. 1-17	65,296.0	92.87	14.06	477,096	2862.57	2200	305	2084	6 and 10
1913									
Nov. 16-30	58,443.0	65.63	17.80	337,428	2016.95	1550	282½	1592	10
Dec	81,266.0	142.89	11.36	663,732	3982.39	1550	578½	1539	10
1914									
Jan	101,436.0	128.15	15.80	624,180	3745.08	1550	528	1576	10
Feb	94,691.0	101.79	18.60	503,670	3022.02	1550	434	1548	10
March	67,449	142.46	9.6	697,722	4186.33	1550	604	1540	10

Material: April, 1910, to August, 1913, inclusive, gravel with overburden of 6 to 15 ft. of clay; September, 1912, to April, 1914, clay. During period from October, 1910, to June, 1911, inclusive, 299,830 cu. yd. out of the total were moved through the 9 per cent flume.

[By the courtesy of Mr. Overstreet, W. L. Church, consulting engineer of the Ambursen Company, was permitted to read the foregoing article before its submission to this journal. Mr. Church has added the following note.—EDITOR.]

When I was inspecting this work a year or more ago, I noticed one interesting feature which Mr. Overstreet has not mentioned. There was a small section, not much more than 100 ft. in length, of one of the terraces which could not be conveniently reached by the sluice boxes. It was found to be cheaper to fill in this section by the usual dry method, with carts, scrapers, etc. This was done with great care and from a selection of the best material. The slope was 1½ to 1. At the time I saw it the slope was covered with a light stand of newly seeded grass.

I noted, however, that on this particular section there was a constant tendency of the surface to creep or slough. The tendency was light, and although it did not result in any considerable damage, the slip was apparently all over the surface, showing that the material was standing just at its natural angle of repose.

Nearby, and part of the same terrace, but of considerably greater height, were sections sluiced in place from all kinds of material as they ran in the bank. Some was fine sand, quite fugitive in its character. This part of the terrace was as stable as though laid in clay and gravel. In fact, I went over the whole length of all the terraces, aggregating several thousand feet, and the only point where there was any trace of slip was in the dry-laid section.

Report on Electrolytic Sewage Treatment at Elmhurst

P. M. Travis, Chemist, Borough of Queens, New York City, Gives Operating Results for 25,000-Gallon Per Day Plant

ELECTROLYTIC treatment has been applied to sewage at an experimental plant installed at Elmhurst, L. I., March 26, and operated under the supervision of the office of the President of the Borough of Queens, New York City, since that date. The plant, patented by C. P. Landreth of Philadelphia, was furnished without expense to the city by the Electro-Chemical Corporation. The following description of the apparatus and the operating data are from a report submitted Aug. 31 to Borough President Maurice E. Connolly by P. M. Travis, chemist for the Borough of Queens. The report is optimistic regarding the possibilities of the method of treatment. Among the phrases used are "startling and excellent results," and "a satisfactory method of sewage disposal has at last been accomplished." The report has been issued so recently that it is not yet possible to tell whether sanitary engineers generally will concur in the conclusions of Mr. Travis. Some of those whom the Engineering Record has sounded upon the subject are decidedly skeptical and foresee no upheaval in present methods of practice as a result of the Elmhurst investigations. An abstract of the report follows:

APPARATUS

The apparatus used for experimental demonstration has a capacity of 25,000 gal. per 24 hours and the dimensions are 2 x 4 x 8 ft. It contains five banks of electrodes 10 x 18 in. spaced ⅜ in. apart, with eleven plates to each bank, thus making a total of fifty-five plates. The first bank of electrodes with which the sewage comes in contact are composed of carbon, while the remaining four are of iron composition. The apparatus is constructed with a heavy cast-iron base, which holds reduction gearing used for operating paddles which rotate between the plates. The action of these paddles insures uniform treatment of the sewage, breaks up all polarization and prevents any deposit from forming upon the electrodes. The power utilized for operating the apparatus was the regular 220-volt 60-cycle alternating current, available at the plant. This supplied, first, a 2-in. centrifugal pump, used to force the sewage through the machine at the rate of 25,000 gal. per day; secondly, to operate a 5 hp motor generator, which in turn operated the machine proper and supplied the direct current used in the process; thirdly, a small motor used for mixing the milk of lime.

The raw sewage is first drawn through a ⅜-in. screen and after leaving the pump enters the electrolytic machine through an opening at one corner of the first plate in the bank of carbon electrodes, passes between the surfaces of the first and second plates and leaves at an opening in the second plate at the opposite corner of the bank. From here it passes between the second and third plates and leaves through the third opening in the corner of the third plate, and so continues to pass back and forth through the ⅜-in. spaces between plates of the electrodes until it has passed through the entire carbon bank.

According to the theory of this process, while the sewage is passing between these electrodes, the sodium chloride (NaCl) present is broken up by electrosis into its component ions or parts. According to the following equation: $NaCl = Na + Cl$, the sodium ions being liberated at the negative and chlorine ions at the positive plates, whereupon the sodium and chlorine react with the water forming sodium hydroxide (NaOH), hydrochloric acid (HCl), and hypochlorous acid (HClO) according to the following equations:

(1) $2Na + 2H_2O = 2NaOH + H_2$.

(2) $Cl_2 + H_2O = HCl + HClO$.

By action of the rotating paddles, these resulting compounds are brought together and react as follows:

(3) $2NaOH + HCl + HClO = NaClO + 2H_2O + NaCl$.

The sodium hypochlorite (NaClO) formed by the above given reaction acts as a germicide by oxidizing the organic matter, including the bacteria, the sodium hypochlorite giving off its nascent oxygen and returning to sodium chloride (NaCl) according to equation:

(4) $NaClO = NaCl + O$ (nascent state).

MILK OF LIME ADDED

The sewage after leaving the carbon electrodes passes between the iron electrodes in a similar manner. At the inlet to the iron electrodes, sufficient milk of lime is pumped into the sewage to make it alkaline. The electrolysis produced by the iron electrodes results as follows: The salts of iron, held in solution by the sewage, are changed to ferric hydroxide, $Fe(OH)_3$, which is a coagulant and helps precipitate the colloidal matter. The electric current acts on the calcium hydroxide ($Ca(OH)_2$) causing the Ca ions to appear at the negative pole and the (OH) ions at the positive pole. As the OH ion is not an attacking ion, the electrodes are not decomposed, and the ions unite to form water and nascent oxygen. The oxygen being in a nascent state acts as a germicide and oxidizing agent on the organic matter in solution and suspension; the calcium does not attack the iron, but unites with the water to again form calcium hydroxide (the same form of lime as introduced) and hydrogen. This hydrogen, being in a nascent state, combines with some of the nitrogen compounds in the sewage to form ammonia. The calcium hydrate is again broken up, and once more performs its function, the calcium reuniting with the water to form the calcium hydroxide and hydrogen gas. Thus the action is cyclic and the small amount of free alkali produces oxygen and hydrogen in proportion to the ampere flow of the current, without decomposition of the iron electrodes. At the same time, part of the lime has combined with the calcium bicarbonate in the water, to form calcium carbonate in a hydrated flocculent form. It also forms with the carbonic acid in the sewage more calcium carbonate, hydrated. This coagulant, together with the resulting effects of the contact of the colloidal matter with the electrodes, whereby they give up their charges which tend to keep them in motion, causes a very rapid precipitation of the suspended matter.

This completes the electrochemical treatment and the time consumed as shown by the phenolphthalein test is approximately 2 min. From here the treated sewage is passed into a weir-box, thence into a sedimentation tank, the dimensions of which are 11½ x 7 x 5 ft. Here rapid sedimentation takes place, a clear effluent flowing out at the top, while the sludge is drawn off through an opening provided at the bottom. Phenolphthalein tests have shown that the clarified effluent leaves this tank in from 10 min. to one-half hour. The clear effluent was then conveyed to a concrete storage tank, which has a capacity of 67,000 gal., where it was retained for observation, while the sludge was passed through a press. The effluent and the liquid from the filter press were clear, odorless and non-putrescent, while the compressed sludge had a slight ammonia or lime odor.

The bacterial removal by the electrolytic process, Mr. Travis states, is practically 100 per cent. The total number of bacteria in the raw sewage varied from 1,000,000 to 3,600,000 per cubic centimeter and averaged about 500 per cubic centimeter after treatment.

On May 28, samples were taken to determine the stability of the sewage after treatment. These samples were colored with methylenegreen and allowed to incubate at 37 deg. C. On June 10, a sample of the effluent from the small sedimentation tank and also a sample from the large storage tank were removed from the incubator, having shown no signs of losing their color, thus showing that the effluent, after the electrolytic treatment, was non-putrescible.

TURBIDITY REMOVAL

The following turbidity removal figures, in parts per million, are given for May 27 by Mr. Travis: Raw sewage, 270; small sedimentation tank effluent, 55; large storage tank, 15. For color removal the figures are (platinum cobalt scale): Raw sewage, 124; small sedimentation tank, 33; large storage tank, 33.

Calculations show that the quantity of lime consumed in neutralizing or in softening the sewage by converting all free carbonic acid and bicarbonates into normal carbonates is 495.7 lbs. of calcium oxide (lime) per million gallons. This is based on an analysis, in parts per million, of the water supply used in the Elmhurst section and which results as follows: Free carbonic acid, 6.6; alkalinity as calcium carbonate, 90.82; total alkalinity as calcium carbonate, 102.0.

The quantity of lime which is pumped in 24 hours for the 25,000-gal. treatment, which is the condition under which these tests were made, is 31.4228 lb., this giving a value of 1256.9 lb. of lime per million gallons. Deducting the quantity of lime which it is necessary to use in softening the water, we have a value of 761.2 lb. As 171.7 lb. of lime as calcium oxide still remain in the large tank according to analytical data, this leaves 589.5 lb. of lime which is actually consumed in the electrolytic treatment of sewage at Elmhurst. As calcium oxide is the active agent in the lime used, the actual cost per ton of lime used in this treatment would be in direct ratio to its purity. The lime used in the above experiments was 78.56 per cent pure calcium oxide; thus to obtain the 1,256.9 lb. of pure calcium oxide used per million gallons, it would be necessary to use about 1,600 lb. gross of lime of this quality. The cost of treating Manhattan sewage by this process would be much less than in Queens Borough, since analysis shows that this water contains only 3 parts per million of free carbonic acid and 33 parts per million total alkalinity calculated to calcium carbonate. From the above data it is readily seen that it would require 180 lb. of lime per million gallons to soften this water. It would therefore require 315.7 lb. less lime per million gallons than we are using in the Borough of Queens. Upon the basis of these calculations Manhattan sewage, if treated by the same process, would require 941.2 lb. per million gallons for treatment.

COST OF CURRENT

The current used and generated by the motor generator for electrolysis on a flow of 25,000 gal. of sewage daily is 18 to 20 amp., with a pressure of 7½ volts, or a power consumption of 135 to 150 watts, which is about 1/5 h.p. The carbon electrodes take about nine-tenths of the current, the balance going to the iron electrodes; hence out of 20 amp 18 go to the carbon and the remaining 2 amp are seriesed eight times on the iron plates, giving an efficiency of 16 amp on the iron. Estimating the power required per million gallons from the above figures, and remembering that with the increase of plate area in larger machines the voltage required to put through a given amperage is proportionately reduced, about 6 kw should be sufficient to effect the high degree of purification obtained in these tests.

Without including pumpage, the necessity of which would have to be determined at each point of treatment, according to topography, the cost of electricity for electrolysis at the rate of 6 kw per million gallons at a cost of 3 cents per kilowatt hour would be:

6 x 24 x .03	$4.32
Lime, 1257 lb., x .003	3.77
	$8.09

GUARANTEES

The Electro-Chemical Corporation guarantees the following results in all its installations:

That the effluent from the final settling tank shall at all times be of such character as to be free from all nuisances causing unsightly conditions in the stream receiving the effluent; deposition of sludge in the stream receiving the effluent; offensive odors within 200 ft. of the plant arising from putrefaction or other decomposition of either the organic content of the sewage or the sludge; danger of infection of the stream receiving the effluent due to the continuous or occasional presence of large numbers of intestinal bacteria in the effluent.

That the effluent from the final settling tank shall be absolutely stable with reference to freedom from decomposition of liquid organic matters or residual suspended organic matters contained therein.

That the plant shall show at all times the following removal of total suspended matters and total bacteria, by standard methods of determination, between the screened sewage and the electrolyzed effluent from the final settling tank: Total suspended matters, not less than 90 per cent.; total bacteria, not less than 99 per cent.

That there shall be no sludge nuisance and that all sludge shall be pressed into an innoxious cake containing not over 70 per cent. of water and in such condition that it can be readily and economically removed and disposed of.

Mr. Travis concludes his report with the following paragraph:

"The above calculations based as they are upon actual analytical data, which have disclosed both chemically and bacteriologically such startling and excellent results, will go to show the low cost of this treatment known at this time. It is very gratifying to be able to state that apparently beyond doubt a satisfactory method of sewage disposal has at last been accomplished."

Small Granite-Cube Pavements

Development in the Use of the Durax Type in Europe and the Two Americas

THE latest specifications for Durax pavement, known in Germany as "Kleinpflaster," and described most recently in the Engineering Record in an article on "Small Granite-Block Pavement in Navy Yard at Brooklyn," on page 81 of the issue of Aug. 16, 1913, refer to granite cubes not more than 4, nor less than 2¾ in. on a side, laid in a ¾-in. cushion of gravel or stone chips, usually on a concrete foundation. Generally the surface of the blocks is rolled, after which hot gravel or crushed stone is swept into the joints, filling the space for half the depth; the other half is preferably filled with a bituminous filler, although specifications for cement grouting are included. A feature strongly specified, a strange one to many American readers, is that the blocks be laid in concentric interlocking segments, as shown in the accompanying illustration.

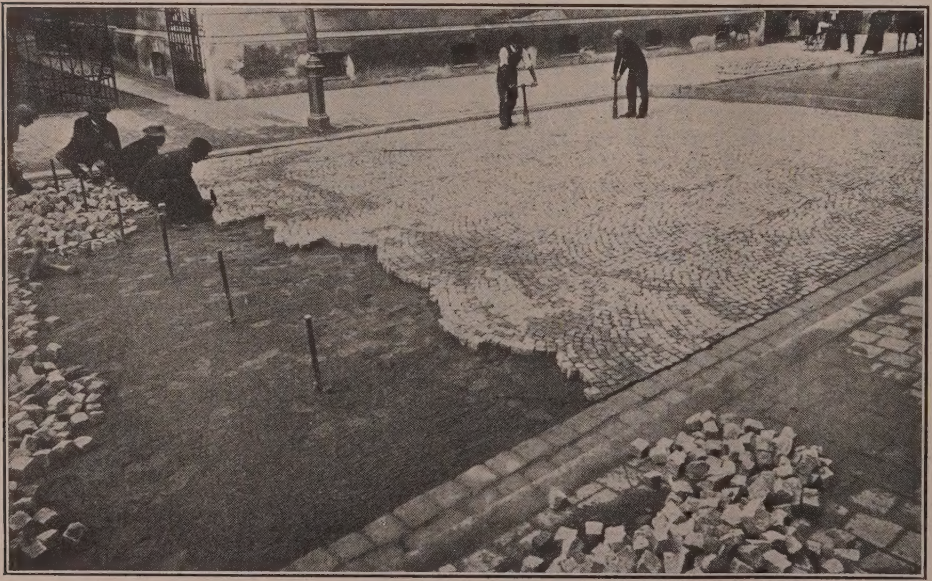
In stating their case, champions of the pavement argue that 3 in. of granite gives a wearing surface that cannot be surpassed, adaptable to residential and commercial districts alike, notably noiseless, offering good traction, and requiring low maintenance and repair expenditures. Especially in Europe, the present tendency is toward a heavy concrete foundation, a particularly reasonable requirement where a granite surfacing material is concerned. The advantage given for the concentric pattern is that no two joints will lie at right angles to the lines of moving vehicles, eliminating not only the wear but the usual noise experienced on a granite pavement.

Objection will naturally be made to the adoption of extremely heavy concrete pavement foundations in American cities, because of the frequent necessity for ripping up our streets. A custom obtains in Sweden, however, that offers an interesting compromise. There the foundation for the small cubes consists of about 6 in. of broken stone laid on a rolled foundation. After the stone itself is rolled, a layer of wet sand is forced into the surface, after which the ordinary filler layer of sand or stone chip is applied. This offers a strong foundation, but one which may be torn up readily if subsurface investigation is necessary.

Considerable experimenting in this country with redressed granite blocks has led to an appreciation of the advantage of the small blocks for affording foothold for horses, and in fact the recent experience of New York City, as told in the Engineering Record of Jan. 3 by R. H. Gillespie, chief engineer, sewers and highways, Borough of the Bronx, suggests a superior applicability to paving purposes. One advantage of the roughly cubical shape of the blocks is that the workmen may quickly determine the most suitable of the three depths. The relatively inexpensive machine-made cubes, therefore, may be incorporated into a fairly regular surface. But where necessary the blocks will accommodate themselves to irregular surfaces just as readily, especially in yielding to the roller.

Another use of the blocks is as surfacing on macadam roads, the pseudo-foundation being carefully brought to grade and covered with a 1-in. layer of the filler aggregate. On page 624 of the Engineering Record of Dec. 6, 1913, appeared a record of experiments in this line in Monroe County, N. Y. The blocks used, however, were of various compositions, not granite, and no attempt was made to lay them in the concentric pattern. As a matter of fact, the best known Durax pavement in this country, that at the Brooklyn Navy Yard, is for the most part laid in rectangular or diagonal courses.

The use of the small blocks in this country is furthered principally by the Wern Stone Paving Company, Inc., of New York City. This company states that the large areas now laid in Chile (1,500,000 sq. yd.) and in the Argentine (1,000,000 sq. yd.), are regarded quite as favorably as the time-tested roads of Germany, France and England. Most of the blocks used in the South American republics are brought from Norway and Sweden. Our granite quarries could not hope to compete in this material, as a minimum freight rate is permitted by the desire of west-bound ships for stone as ballast. It is said that artistic use is made of the cubes by the South Americans in laying vari-colored patterns.

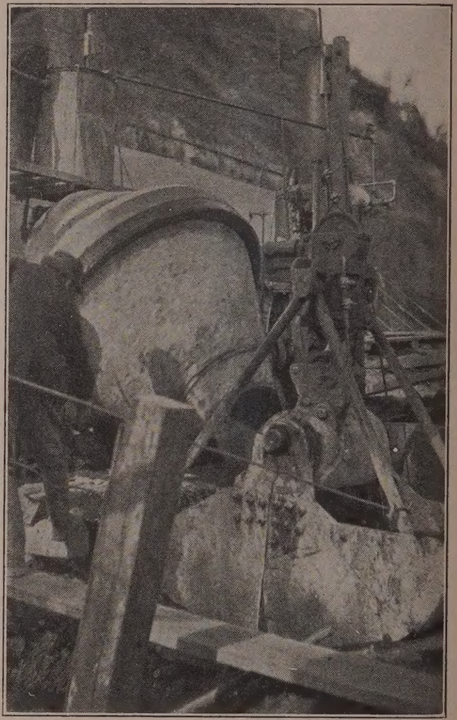


DURAX PAVEMENT UNDER CONSTRUCTION IN MUNICH, BAVARIA

A Versatile Clamshell Bucket

Making the Excavator Do All the Heavy Work in the Construction of a Reservoir at Burlington, Iowa

A ONE-YARD, type E, Owen clamshell bucket operated by the 80-ft. boom of a guy derrick was used for all the excavation, for supplying crushed stone and sand to the storage hoppers of the concrete plant, and for handling about 5000 cu. yd. of concrete used in the construction of the citizen's waterworks reservoir at Burlington, Iowa. Its service avoided the use of two derricks, or of two buckets, and the delay of time in shifting buckets and the loss of time of an additional derrick and crew enabled a single derrick to be constantly employed.



CLAMSHELL HANDLING CONCRETE

As the forms for the reservoir walls were only about 12 in. wide at the top, a traveling hopper moving on them was provided for the buckets to discharge into, chutes being eliminated, and only two men being required, one to operate the bucket and the other to place the concrete. Although the concrete was mixed wet, there was no spilling in transit, because the bucket shell or bowl was of the practically watertight type used for dredging buckets. The work was executed by the Phee Construction & Engineering Company of Chicago.

CEMENTITIOUS WASTE remaining after the recovery of coal by washing from the culm banks in the anthracite regions of Pennsylvania is utilized by flushing it into mines and partly filling old workings to support the roof when the coal previously left for pillars is removed.

EASTBOUND CLASSIFICATION YARD AT CLEARING, AS SEEN FROM THE HUMP

Chicago's Reconstructed Clearing Yard

Brief Sketch of the Economics, Design and Operation of What Is to Be One of the Largest Freight Yards in the World

A DOZEN years ago a large yard was built by the Chicago Union Transfer Railway at Clearing, Ill., just outside the city limits of Chicago, at Forty-eighth Avenue and Seventieth Street. Its purpose was to handle the interchange business of all roads entering the city. Whether the design, the operating arrangement or the whole scheme was at fault, the project did not succeed. Nevertheless, some eighteen months ago a plan was perfected for rehabilitating and enlarging the yard, as described in the Engineering Record of June 28, 1913, page 730. The work described then, which constitutes the first of three units, is now nearing completion.

For many years the railroads have built small yards at various points in and around Chicago, and as there was no large central clearing yard each road had to do its own classifying to a greater or less extent. As a result, in making up freight from one road to be delivered to another, time was either lost in waiting for enough cars to accumulate to make haulage worth while or else operating costs were boosted skyward by the light-engine movement resulting from an effort to avoid delay by taking a few cars at a time from one road to the other. With the opening of the "Clearing yards" these difficulties will be obviated. Each road will send full trains of interchange cars over the Belt Railway to the yards, where they will be classified, allowing quick and heavy shipments to be made. With all roads pouring their freightage into Clearing, it will be a comparatively easy matter to make up heavy trains for all lines.

DESIGN

The yards were designed with a view of providing an interchange point for through shipments, thus doing away with the necessity of handling through the downtown terminals. One of the main ideas back of the design of the yards was to avoid every possible interference with the flow of traffic. The engineers were limited to the present position of the yard in a general way owing to the fact that Clearing was about the only place around Chicago where property of a sufficient size was available in such a large block, and at the same time was centrally located with respect to all the railroads and had easy access to two belt railways. Movement from one side of the yards to the other is taken care of by run-around tracks, which cross the yards by means of two depressed tracks under the hump. By means of these tracks "back-up" business received from one direction to be sent in the same direction may be taken in at one end of the yard, classified and taken back to the departure tracks at the same end that it entered. The run-around tracks also give access to the locomotive and car-repair shops.

Another aim of the design was to advance freight for a given direction as near as possible through the yard always in the same direction without any back-up movement. The yards when completed will be about 5 mi. long and ½ mi. wide. The first unit, which is nearing completion, will contain about 150 mi. of trackage, will be able to handle 10,000 cars per day and will cost approximately $10,000,000. Room is provided for similar additional units, which will be constructed as required.

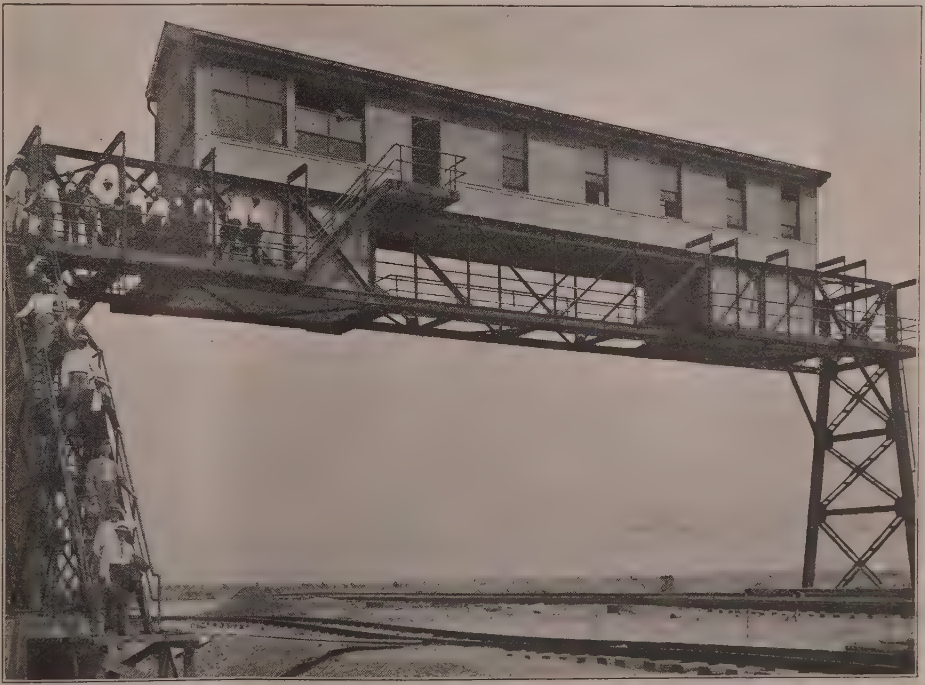
The plan of the proposed reconstructed yard, shown in the previous article referred to, has been carried out with few changes. The yard will be operated by gravity, with four tracks, two in each direction, on the hump, and will have a working capacity over the hump of about 400 cars per hour. The approach tracks to the hump have a 0.6-per cent grade. On leaving the hump the tracks descend on a 4-per cent grade (instead of 2.25 per cent, as shown in the article referred to) for a short distance to give the cars the required initial velocity, then ease off to a 0.9-per cent grade through the ladders and to 0.4-per cent grade through the body tracks. These grades are deemed sufficient under existing conditions to keep the cars in motion.

ADJUSTABLE HUMPS

To compensate for wind resistances, as the prevailing winds around Chicago are from the west and the yards run east and west, the westbound hump has been tentatively made a foot higher than the eastbound hump. In cold weather the running gears of the cars stiffen up considerably, and it is necessary in humping cars to give them a higher velocity. To do this, the layout of tracks over the hump has been designed to permit raising or lowering several feet to meet varying conditions. The two classification yards (one eastbound and one westbound) are made up of two units of twenty-six tracks each, with running tracks through each unit and between the two, making a total of fifty-five tracks in each classification yard.

The two tracks each way over the hump are reached by four approach tracks in each direction. This cuts the idle time of the hump between trains to the minimum, for as fast as one train is humped another is right on hand on the other approach track and does not have to wait any appreciable time to hump its train. As a result the train interval over the hump is brought down to the lowest limit.

Either road or transfer engines will


HUMP TOWER FROM WHICH CLASSIFICATION YARDS WILL BE OPERATED

bring in and take out trains from the Clearing over the rails of the Belt Railway of Chicago. Roads from the east and south enter the yard from the east end. Those from the north and west have access to the western end of the yards. Receiving and departure yards, with all the necessary facilities for coaling, watering and turning engines, will be located at each end of the yard and road, or transfer engines will not go beyond these points.

After an engine brings a train into the receiving yards it is uncoupled and goes through to the engine tracks, where it is run on a turntable and turned. It then obtains water, coal and sand and cleans out over the cinder pit. After this grooming the engine is run out on a running track between the receiving and departure yards to the far end of the yard, where it is backed up on the departure tracks against a string of cars ready for the same line from which the engine came. The caboose coming in on a train is uncoupled and taken to caboose tracks at the hump end of the departure yards, whence it is pushed up against the train destined for the particular road to which the caboose belongs. After a section of cars has been brought from the classification yard to any departure track the switch engine uncouples, runs out on a ladder track, backs up and brings up another section of cars to complete the train's quota. The engine is then between the two sections, and to get it out every third track in the departure yards has been made a running track connected with the standing tracks on either side by the proper crossover. When the caboose is backed up these two sections are coupled together.

AUXILIARY FACILITIES

Roads operating into the clearing yards will thus effect a direct interchange at a point outside of the city, thereby eliminating the delays which now occur owing to the fact that the roads do not make direct connections except via routes leading through congested portions of the city. In addition to the arrangements for handling carload shipments, facilities will also be provided for transferring less-than-carload business, reducing the congestion in city freight houses and eliminating delays in handling.

A combination of air whistles, semaphores and lamps will be used for signaling the engines pushing trains over the humps. The signals will be operated from the hump tower, as will all switches in the classification yards. These switches are controlled by an electro-pneumatic push-button machine. The interlocking apparatus is located in a bridge spanning the hump tracks and about 35 ft. above them and about 60 ft. above the natural level of the ground. From this bridge a clear view of all parts of the yard is obtained. The air whistles will be used during foggy weather.

The yards were designed by E. H. Lee, vice-president and chief engineer of the Chicago & Western Indiana Railroad and also of the Belt Railway of Chicago. The designs were approved by a committee of engineers representing the twelve owning companies of the Belt Railway of Chicago.

NO PASSENGERS KILLED in three years is the record of the New York Central & Hudson River Railroad. In that time 136,154,983 persons have been carried on 1,236,654 passenger trains.

What the U. S. Reclamation Service Has Accomplished

Detailed Statement of Work Done Involving Movement of 113,000,000 Cubic Yards of Earth and Rock and Building of 8,500 Miles of Canal

THROUGH the courtesy of Director F. H. Newell the Engineering Record is enabled to give in the accompanying table a résumé of the results accomplished by the U. S. Reclamation Service to June 30, 1914. These data will appear in the forthcoming annual report of the Service. One of the notable features is that 113,000,000 cu. yd. of earth, rock, etc., have been moved since the Reclamation Service was initiated in 1902. There have been built 8500 mi. of canals and distributing systems, 86 tunnels with an aggregate length of nearly 25 mi., 733 mi. of wagon roads, and 78 mi. of railroads, etc. The table gives the comparison between the results at the end of June 30, 1913 and 1914.

THREE CONVICT ROAD CAMPS have been established in West Virginia. The men are moving material at a cost far less than are citizen-labor crews.

SUMMARY OF RESULTS, U. S. RECLAMATION SERVICE, JUNE 30, 1914.

	To June 30, 1913		To June 30, 1914	
Lands—	Acres	Farms	Acres	Farms
Area of 28 projects when completed	2,973,048	60,569	2,996,165	60,593
Service was prepared to irrigate	1,290,107	26,674	1,351,193	27,265
Under contract—				
Water rights	431,457	8,786	416,644	8,559
Rental contracts, etc.	510,815	12,168	570,843	12,466
Total under contract	942,272	20,954	987,487	21,025
Available reservoir capacity	5,051,210 acre-ft.		5,426,510 acre-ft.	
Canals and ditches—				
Canals over 800 sec.-ft. capacity	313 mi.		325 mi.	
Canals 301 to 800 sec.-ft. capacity	471 mi.		538 mi.	
Canals 50 to 300 sec.-ft. capacity	1,206 mi.		1,318 mi.	
Canals less than 50 sec.-ft. capacity	5,538 mi.		5,826 mi.	
Waste-water and drainage ditches	433 mi.		548 mi.	
Total canal and ditches	7,961 mi.		8,555 mi.	
Tunnels—Number and length, feet	77; 117,760 ft.		86; 129,341 ft.	
Dams—Storage and diversion—				
Masonry	868,176 cu. yd.		1,346,904 cu. yd.	
Earth	7,955,067 cu. yd.		8,817,236 cu. yd.	
Rockfill and crib	700,409 cu. yd.		704,784 cu. yd.	
Total	9,523,652 cu. yd.		10,868,924 cu. yd.	
	Length	Volume	Length	Volume
Dikes or levees	82 mi.	3,697,228 cu. yd.	85 mi.	3,790,950 cu. yd.
Canal structures—	Concrete	Wood	Concrete	Wood
Costing over $2,000	576	51	645	75
Costing $500 to $2,000	1,152	178	1,264	206
Costing $100 to $500	5,715	3,475	5,978	3,748
Costing less than $100	5,044	34,022	5,622	37,087
Total	12,487	37,746	13,509	41,116
	No.	Length, ft.	No.	Length, ft.
Bridges—				
Steel	81	5,033	84	5,337
Combination	302	6,910	195	6,094
Wood	2,767	56,325	3,386	70,603
Concrete	191	2,632	210	3,191
Total	3,339	70,900	3,875	85,225
Culverts—				
Concrete	1,130	47,897	1,120	51,105
Metal	672	16,779	880	26,338
Terra Cotta	196	9,679	306	16,191
Wood	1,853	46,080	2,329	54,628
Total	3,851	120,435	4,635	148,262
Pipe—				
Concrete		433,212		454,584
Metal		32,287		153,638
Terra Cotta		181,339		451,928
Wood		184,149		192,036
Total		830,987		1252,186
Flumes—				
Concrete	28	3,039	29	3,123
Metal	238	74,712	297	90,126
Wood	1,171	323,640	1,264	328,375
Total	1,437	401,391	1,590	421,624
Canals lined, miles	No report		Cons. Wood	86.4 mi. 1.7 mi.
Buildings—				
Offices	65		74	
Residences	426		483	
Power Plants	14		13	
Pumping Stations	61		63	
Barns, storehouses, etc.	332		385	
Total	898		1,018	
	No.	Depth, ft.	No.	Depth, ft.
Wells	348	26,237	361	28,717
Communications—				
Roads	697 mi.		733 mi.	
Railroads	51 mi.		78 mi.	
Transmission lines	357 mi.		402 mi.	
Telephone lines	2,331 mi.		2,376 mi.	
No. phones	927		1,003	
Power developed—				
Water	28,866 hp		29,126 hp	
Steam	3,600 hp		4,250 hp	
Total	32,466 hp		33,376 hp	
Excavation—				
Class 1, earth	87,492,753 cu. yd.		100,432,925 cu. yd.	
Class 2, indurated material	6,296,118 cu. yd.		6,668,156 cu. yd.	
Class 3, rock	5,456,897 cu. yd.		6,067,391 cu. yd.	
Total	99,245,768 cu. yd.		113,168,472 cu. yd.	
Coal mined	30,693 tons		39,474 tons	
Rip rap placed	419,790 cu. yd.		616,493 cu. yd.	
Paving placed	511,322 sq. yd.		564,037 sq. yd.	
Concrete placed	1,344,908 cu. yd.		1,933,263 cu. yd.	
Cement used	1,533,544 bbl.		1,965,499 bbl.	
Cement manufactured by U. S.	338,452 bbl.		338,452 bbl.	
Sand-cement manufactured by U. S.	95,435 bbl.		597,916 bbl.	

Shoring Dey Street Buildings, New York

Springers with Double-Cantilever Girder Fulcrum—Multiple Pushers for Eleven-Story Pier—Girders Underpinned by Cantilever Wall Grillages

LARGE caissons for the wall columns of the tall steel office building for the Western Union Company at 14, 16 and 18 Dey Street, New York City, were sunk through quicksand to rock adjacent to the party walls of the neighboring buildings, Nos. 12 and 20, as described in the Engineering Record of Feb. 28, page 252. To safeguard the existing structure against settlement from the deep excavations alongside, the wall of No. 20 was temporarily supported on compound sets of adjustable girders, and the wall of No. 12 was braced by heavy compound spurs and underpinned by steel and concrete cylinders supporting grillages that also carry the ends of original transverse foundation girders. In both cases the work was executed from the interior of the building without interfering with tenants in the upper stories.

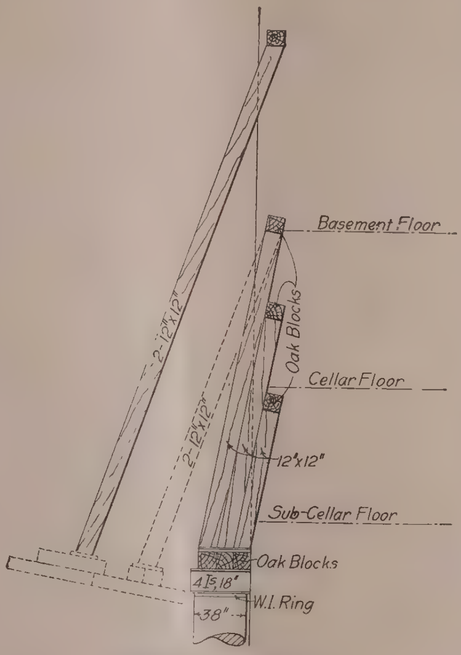
SHORING 20 DEY STREET

The four-story building at 20 Dey Street has a front of 24 ft. and is about 76 ft. deep. Its party wall adjacent to the Western Union Building is built up to the lot line and has a thickness of 18 in. at the base just above the footing on the sand. The estimated weight of the wall and its load was about 10,000 lb. per linear foot. Four pneumatic caissons, together occupying the full length of the wall, were sunk within 6 in. of its base to a depth of about 80 ft. below the old footing.

Before the caisson sinking was commenced the wall was supported on six sets of cantilever shoring girders, called springers, which were fulcrumed a short distance inside the wall and reacted against the opposite wall of the building, thus making the supports entirely self-contained and avoiding any obstruction of the Western Union Building lot. The cantilevers at each end of the wall were oblique to it, so as to give it support near the extremity and secure reaction in the opposite wall at some distance from the end All of the other cantilevers were at right angles to the wall.

One of the intermediate cantilevers consisted of two sets of girders, one on each side of the partition wall. All of the other cantilevers were single sets of I-beams. All of the intermediate beams except one set of the double cantilevers extended across the full width of the building and took full bearings under both walls, thus having a uniform length of 24 ft. Three intermediate cantilevers and one end cantilever were fulcrumed on pairs of timbers with jackscrew supports on timber grillages.

The double cantilever and the two single cantilevers at one end of the building were fulcrumed on double cantilever I-beams parallel to the shored wall. The fulcrum beams were themselves fulcrumed near each end on a pair of transverse timbers perpendicular to the shored wall, supported by jackscrew bearings and timber grillages. During the progress of the caisson work levels were frequently taken, and as fast as any settlement was detected the jackscrews were operated to maintain the cantilever girders at their original level, thus compensating for any displacement of the soil.



CORNER SHORING AT AA

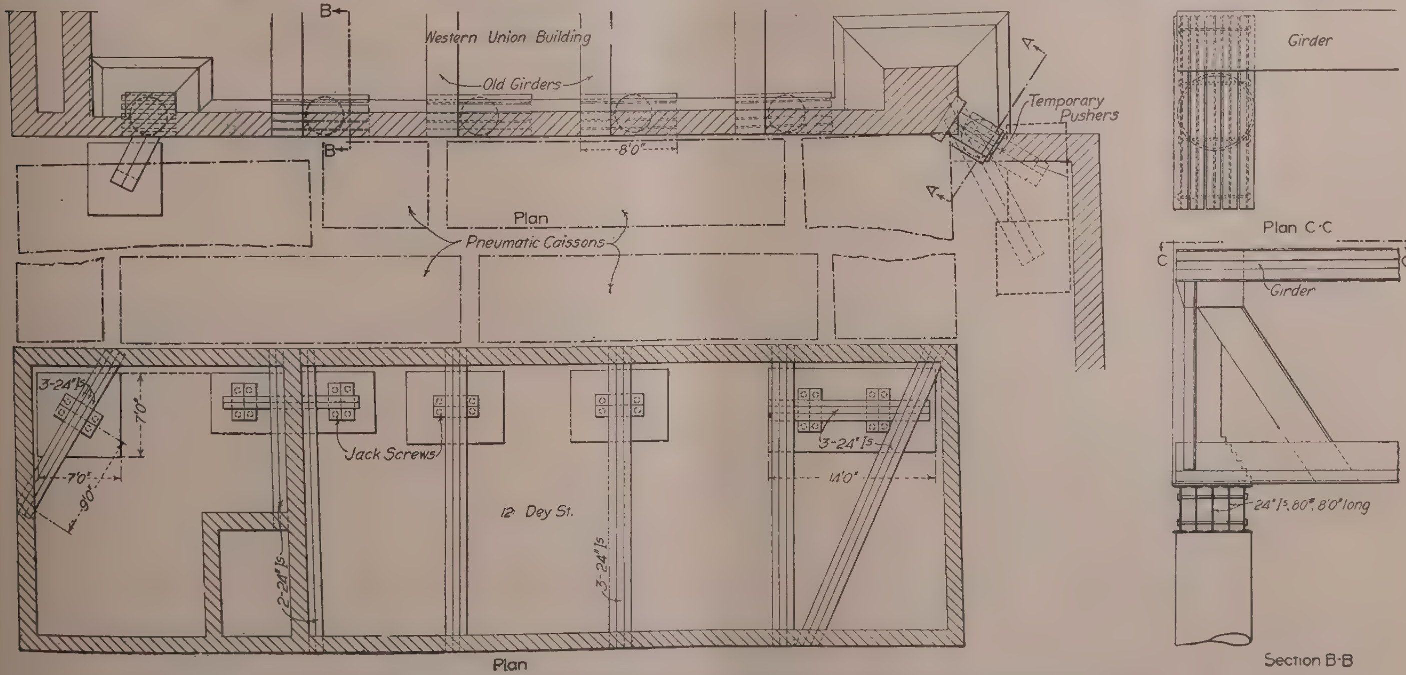
BRACING 12 DEY STREET

The eleven-story building at 12 Dey Street has interior columns and a party wall 21 in. thick at the base and about 80 ft. long that are carried by four foundation girders, transverse to the lot line, which support estimated loads of 400 tons each. As on the opposite side of the Western Union Building, large caissons were sunk to a great depth below the wall close to its footing, and to prevent settlement or displacement of the latter it was underpinned and braced before caisson excavation was commenced.

The bracing consisted of timber spurs or pushers in vertical planes oblique to the face of the wall at each end. All of the spurs were made of 12 x 12-in. timbers with horizontal oak caps recessed into the face of the brickwork and with wedged bearings on timber grillages. In the rear of the lot the spurs were about one story high and the grillage slightly overlapped the position of one of the pneumatic caissons and was removed after the underpinning was completed and before this caisson was sunk.

At the front of the lot the very heavy corner pier was braced by two sets of spurs, in different vertical planes. The footings of both were located outside of the building line, where they did not interfere with the caisson sinking.

The shorter and lower spur, proportioned for a load of 400 tons, consisted of three pairs of 12 x 12-in. timbers engaging the brickwork at different heights between the cellar and basement floors, thus distributing the pressure which was transmitted to a permanent foundation cylinder sunk for the purpose just outside of the building line. While this foundation cylinder was being sunk the corner of the building was braced by a temporary spur engaging the upper cap of the compound spur and seated on a timber grillage clearing the foundation



ARRANGEMENT OF SHORING NEEDLEBEAMS, SPRINGERS AND CANTILEVERS AND UNDERPINNING CYLINDERS AND BEAMS cylinder. Another spur engaged the wall of the building near the first-floor level and had a wedged bearing on a timber grillage in the sidewalk vault. The six pieces forming the short spur were cross-bolted together to make a single 24 x 36-in. solid mass of timber.

UNDERPINNING SIDE WALL

The foot of the wall was recessed to receive short sections of cast-iron cylinders 3 ft. in diameter which were located as close as possible to one side of each of the four transverse foundation girders. The cylinders were excavated and jacked down to rock, concreted and capped with four 24-in. 80-lb. I-beams 8 ft. long parallel to the face of the wall, and the brickwork and ends of the foundation girders were wedged up to bearing on them and grouted. The I-beams act as cantilevers supporting the foundation girders and reacting against the wall on the opposite sides of the cylinders.

William Welles Bosworth is the architect of the Western Union Building. The caisson work, underpinning and shoring were executed by the Foundation Company under the direction of C. S. Rindsfoos, secretary.

Hell Gate Arch Details

Top and Bottom Chord Construction and Connections at Panel Points of Long-Span Four-Track Structure Over East River, New York

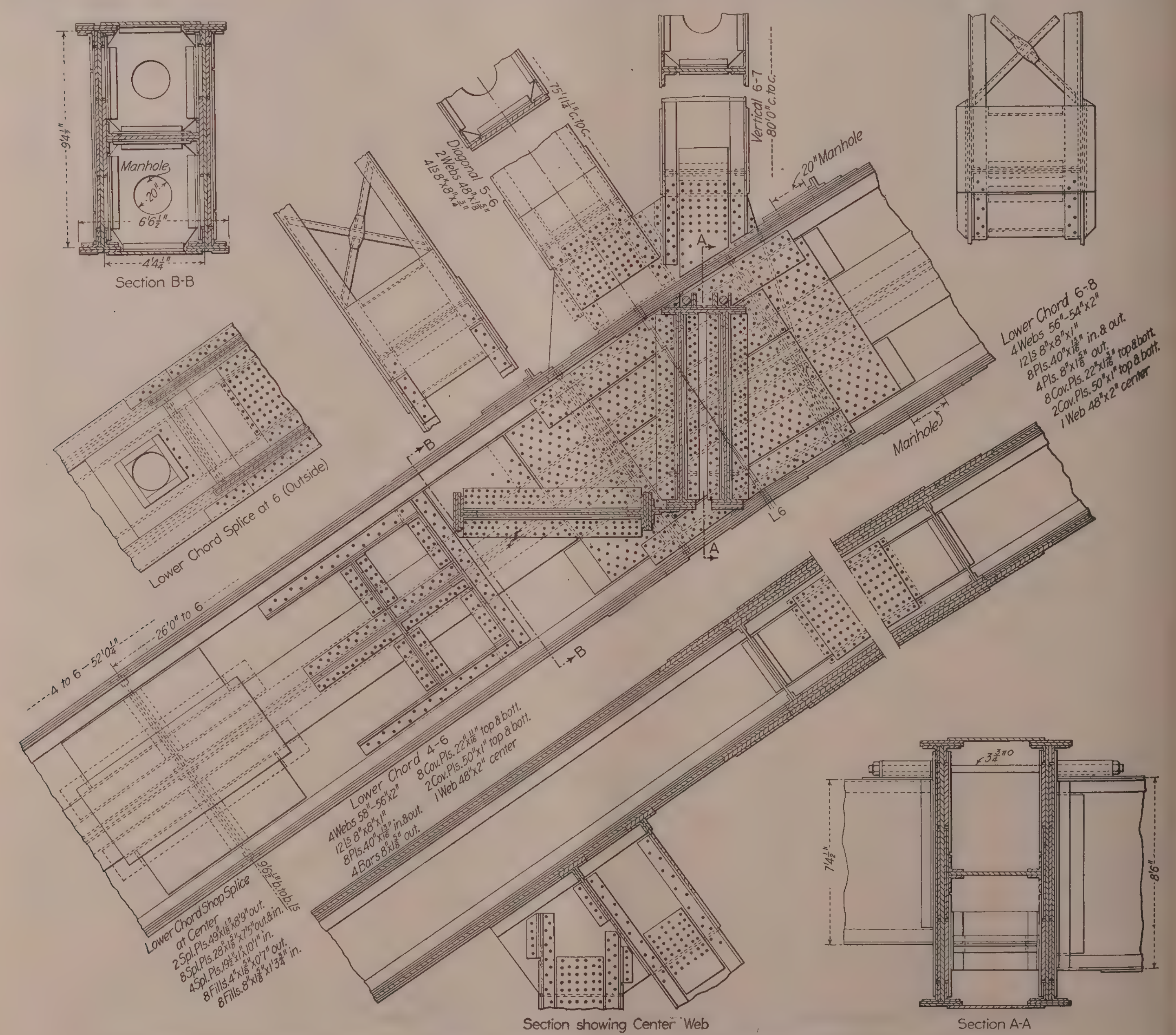
THE steel superstructure of the long span four-track Hell Gate arch bridge over the East River, New York City, has much longer and heavier trusses than any other span of a similar type. The lower chord is the principal member and is unusual on account of its great dimensions, the manner in which the cross-section is built up—its elements reinforced to develop the potential column strength—and for the method of splicing intended to differentiate dead and live load stresses.

The spandrel-braced, two-hinge trusses have a span of 977 ft. 6 in. between centers of bearings, a lower chord rise of 220 ft., a depth of 40 ft. at the crown and 140 ft. at the skewbacks, as shown by diagram and part elevation in the general description published in the Engineering Record of June 27, page 734. The lower chords, which are parabolic arcs, and the top chords, which are reversed segmental curves, are connected by vertical posts 42½ ft. apart, with single diagonal braces in the panels between them. All members are of high-carbon steel, with rivets generally 1¼ in. in diameter.

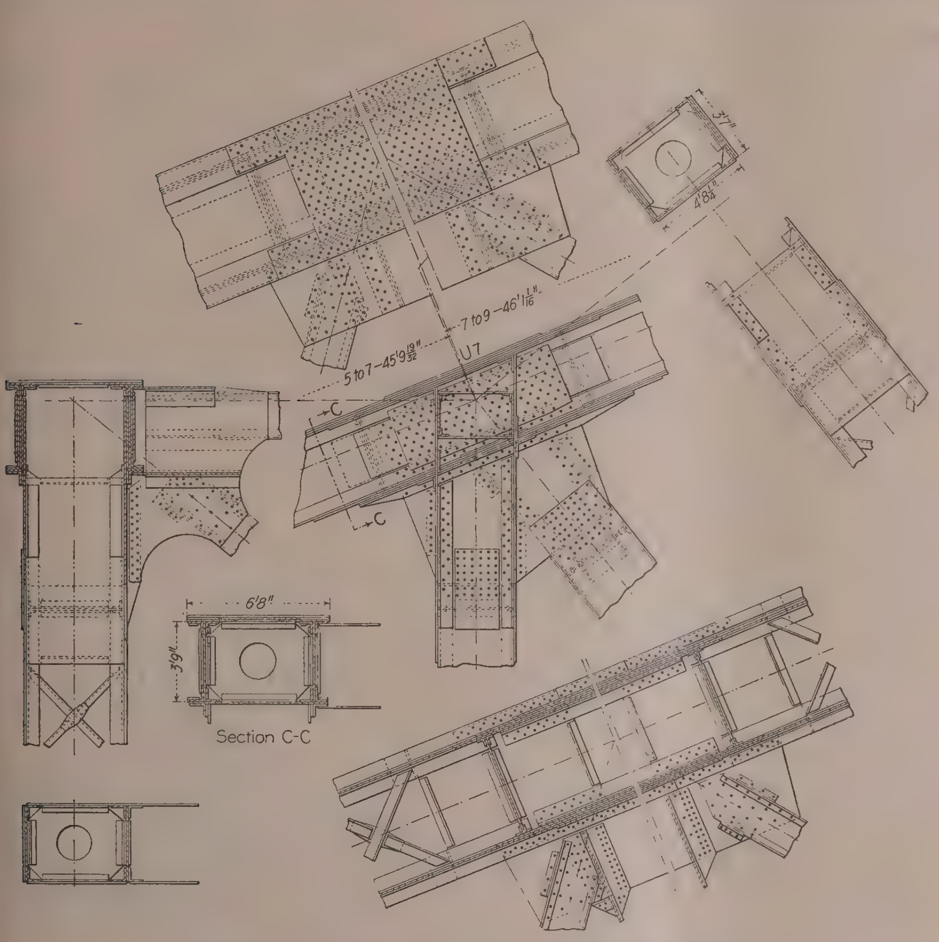
Except at the ends of the truss, where some of the vertical posts carry the floorbeams, the web members of the trusses are substantially uniform and have a rectangular cross-section made of two built channels latticed with angle bars. All of them are field-riveted between sections of the chord webs, which project beyond the flanges to form jaw plates.

All members are shop riveted complete and shipped in single lengths, except the end posts, which are spliced just above floor level. The heaviest shipping weight is about 100 tons. The largest computed stress, except in the floorbeam members, is 2,070,000 lb., for which is provided a cross-sectional area of 137 sq. in. The end vertical post, 140 ft. long, has a cross-sectional area of 315 sq. in.

The trough-shape top chord is made of two built I-beams 48 in. deep and about 60 in. apart on centers. They are special in that the top flanges are reinforced by cover plates on which is riveted the main cover plate connecting them. The bottom flanges


9'4¼"
Manhole
20"
6'6½"
4'4½"
Section B-B
Diagonal 5-6
2 Webs 48"x1⅝"
4 Ls 8"x8"x¾"
75'11¼" c. to c.
Vertical 6-7
80'0" c. to c.
20" Manhole
A
A
B
B
L6
Manhole
Lower Chord 6-8
4 Webs 56"-54"x2"
12 Ls 8"x8"x1"
8 Pls. 40"x1 3/16" in. & out.
4 Pls. 8"x1⅝" out.
8 Cov. Pls. 22"x1 3/16" top & bott.
2 Cov. Pls. 50"x1" top & bott.
1 Web 48"x2" center
Lower Chord Splice at 6 (Outside)
4 to 6 — 52'0¼"
26'0" to 6
Lower Chord 4-6
4 Webs 58"-56"x2"
12 Ls 8"x8"x1"
8 Pls. 40"x1 13/16" in. & out.
4 Bars 8"x1⅝" out.
8 Cov. Pls. 22"x11/16" top & bott.
2 Cov. Pls. 50"x1" top & bott.
1 Web 48"x2" center
Lower Chord Shop Splice at Center
2 Spl. Pls. 49"x1⅛"x8'9" out.
8 Spl. Pls. 28"x1⅝"x7'5" out. & in.
4 Spl. Pls. 19½"x1"x10'1" in.
8 Fills. 4"x1⅝"x0'7" out.
8 Fills. 8"x1⅝"x1'3¾" in.
9'6½" b. to b. Ls
Section showing Center Web
3¾"
7'4½"
8'6"
Section A-A

DETAILS OF LOWER CHORD, DIAPHRAGM, SPLICE AND WEB MEMBER CONNECTIONS AT PANEL POINT L6



TOP-CHORD SPLICE AND CONNECTIONS AT PANEL POINT U7

are connected by angle-bar latticing. The chords are made in single-panel lengths with full-bearing ends faced radially and fully spliced field-riveted joints. The maximum computed top-chord stress is 7,730,000 lb., for which there is provided a cross-sectional area of 385 sq. in. The shipping weight of the heaviest top chord section is 40 tons. The webs are connected by transverse vertical diaphragm plates at panel points and intermediately.

BOTTOM CHORDS

The bottom chords have a closed double-rectangular cross-section with a uniform width of 6½ ft. over all and a depth over all varying from 7½ ft. at the crown to about 11½ ft. at the skewbacks. Their main elements are two vertical webs 2 in. thick with pairs of flange angles on the upper and lower edges. These angles have horizontal reinforcement plates receiving the thick cover plates that connect the two webs. Owing to the great depth of the chords the web plates are made in two pieces spliced on the center longitudinal lines, where also pairs of continuous angles are riveted to the inner faces to provide connection for a continuous horizontal longitudinal diaphragm plate connecting the webs and forming with them an H-shape section. The webs are also connected at panel points and intermediately by transverse diaphragms in planes at right angles to the axis of the chords.

The chords are straight between panel points where they change direction and have field-riveted joints radial to the parabolic curve. At these joints the vertical webs are cut for contact bearing on the middle third, and taper from there to the outer edges to provide clearance of ⅛ in. between adjacent sections at the flanges. This arrangement concentrates the web bearing near the center line of the chords and produces during erection an effect approximating that of hinge bearings, thus controlling the distribution and transmission of dead-load stresses.

These joints are spliced with 70 to 80 per cent riveted cover plates, which provide for live load stress distribution uniformly throughout the member. Fabrication splices of the heavy web plates intermediate between the panel points are shop-riveted complete, and in them the ends of the webs are in contact throughout, without the tapered clearances provided at panel points. Manholes through the top and bottom cover plates at the ends of the members and through the transverse diaphragms give access to the interior for riveting the top and bottom flange cover plates.

The maximum computed chord stress is 28,650,000 lb., for which there is provided a cross-sectional area of 1385 sq. in. This section has a shipping weight of about 185 tons, its web plates are 2 in. thick, and the flanges are made of 8 x 8 x 1-in. angles.

FLOORBEAMS

The horizontal floor platform intersects the lower chords at panel point L6, where the box-girder floorbeam is field-riveted through hitch angles to the chord webs, as shown in the details. At this point the special floorbeam is continued on the opposite sides of the lower chords and carries the sidewalk on cantilever brackets about 13½ ft. long. These brackets are connected to the lower-chord webs in the same manner as are the main floorbeams, and the tension in both top flanges is provided for by horizontal tension rods which pass through holes provided in the lower chord webs and connect them with the main floorbeams, taking bearing on the top flange distributing angles shown in the detail. The thrusts from the lower ends of the cantilever brackets are transmitted to the main floorbeams through reinforced vertical transverse diaphragms connecting the chord webs.

Adjacent to the L6 floorbeam a traction plate girder with a horizontal web 8 ft. deep is field riveted to the chord webs through hitch angles. Connection plates and angles are field-riveted to the side webs just clear of the traction girders to provide attachment for the lower-chord lateral members.

Samuel Rea is president of the New York Connecting Railroad, and Gustav Lindenthal, consulting engineer and architect, designed the bridge and is acting as chief engineer of construction. O. H. Ammann is assistant chief engineer and H. W. Hudson is construction engineer. The American Bridge Company is the contractor for the fabrication and erection of the steelwork, the P. Ryan Construction Corporation for the tower bases, and the Snare & Triest Company for the towers. The deep foundation for the Ward's Island tower was constructed by the railway company on force account, under the direction of Mr. Lindenthal, Paul G. Brown acting as managing engineer.

Secretary of War Cables Goethals Congratulations on Opening of Panama Canal

A MESSAGE of congratulation from Lindley M. Garrison, Secretary of War, cabled Aug. 15, to Col. George W. Goethals upon the opening of the Panama Canal reads as follows:

"On behalf of the Government and the people of the United States I express to you and through you to all concerned in the achievement the intense gratification and pride experienced to-day. By the successful passage of vessels through the canal the dream of centuries has become a reality. Its stupendous undertaking has been finally accomplished and a perpetual memorial to the genius and enterprise of our people has been created. The fully-earned and deserved congratulations of a grateful people go out to you and your colaborers."

RAISING THE BOSTON BRIDGE over the Youghiogheny River, at McKeesport, Pa., a number of years ago was recently described by Herman Laub in a discussion before the Engineers' Society of Western Pennsylvania. The bridge had a 350-ft. cantilever span and two 175-ft. end spans. One of the end spans on a 5-per cent grade, over curved tracks of the Baltimore & Ohio Railroad, was lifted 17 ft. in nine days and supported on a steel grillage laid in concrete on top of the stone pier. Another interesting bridge job described by Mr. Laub was the construction of a new anchorage for the long-span Seventh Street suspension bridge over the Allegheny River in Pittsburgh. One of the anchorages had settled and moved forward 5½ in. The braced chains were disconnected from it and attached to the new anchor chains, the center of the span was lifted by hydraulic apparatus and the whole bridge connected up within 36 hr.

Economic Design of Penstocks

Determination of Advantageous Diameter of Steel Pressure Pipes, Considering First Cost, Depreciation, Interest and Value of Power Lost

By MELVIN L. ENGER
Assistant Professor of Theoretical and Applied Mechanics, University of Illinois

DETERMINATION of the economical diameter of a penstock was well discussed by Frank H. Carter in an article published in the Engineering Record of Dec. 27, 1913, page 725. By his method the penstock will be of uniform diameter from top to bottom. In many designs for penstocks under high heads it has been found economical to decrease the diameter as the head increases. An ingenious graphical method for determining the economical diameters of the various sections of the Jawbone inverted siphon of the Los Angeles Aqueduct is given by E. R. Bowen in the Engineering Record of Dec. 20, 1913, page 682. It is shown that a considerable saving was made by varying the diameter.

In this paper an analytical method for determining the economical diameter will be presented. The proof will be based on the following proposition: A penstock is most economically designed when the annual interest and depreciation plus the annual value of the power lost in overcoming frictional resistances is a minimum.

NOMENCLATURE

In the equations to follow h = head on section of penstock under consideration in feet; d, economic diameter of this section of the penstock in inches; t, thickness of plates in inches; n, per cent overweight due to laps, cover plates, etc.; w, weight of 1 cu. ft. of steel in the penstock (490 lb.); a, cost of the steel in dollars per pound; b, annual value of lost power due to frictional resistances, in dollars; r, rate of interest plus depreciation, in per cent; c, coefficient in the Chezy formula; s, slope of the hydraulic gradient = loss of head per foot of penstock; E, overall efficiency of the turbine and generator, in per cent; Q_1, Q_2, etc., quantities flowing for z_1, z_2, etc., hours per day respectively, in second-feet.

The weight of a section of the penstock 1 ft. long is:
$w\pi td(1+n)/144 = 10.7td(1+n)$ pounds. The annual interest and depreciation will therefore be,

$$C = 10.7artd(1+n) \text{ dollars.} \qquad (1)$$

From the Chezy formula,

$$s = 48v^2/c^2d$$

Since $Q = \pi d^2v/576$

$$v = 576Q/\pi d^2$$

The horse-power used in overcoming frictional resistances per foot of penstock, when the quantity being discharged is Q sec.-ft. is therefore

$$P = 183400Q^3/c^2d^5 \qquad (2)$$

The annual value of the lost power is

$$L = 7640Eb(Q^3_1z_1 + Q^3_2z_2 + \text{etc.})/c^2d^5 \text{ dollars} \qquad (3)$$

The total annual cost of this foot of penstock is found by adding equations (1) and (3). To determine the economic diameter, equate the first derivative of the total annual cost with respect to the diameter to zero.

$$d = 3.91\left\{Eb(Q^3_1z_1 + Q^3_2z_2 + \text{etc.}) \div [artc^2(1+n)]\right\}^{1/6} \qquad (4)$$

It will be seen that in any penstock the diameter should vary inversely as the sixth root of the thickness of the plates in order to have minimum weight of steel. The second column of the table gives the relative diameters which the parts of various thicknesses should have, calling the diameter of the section of ¼-in. thickness unity.

If the slope is uniform, the penstock of uniform diameter which will have the same loss of head as the one of varying diameters is given in the third column. For example, the relative diameters of the economic penstock whose lower plates are 1 in. thick vary from 1.000 to 0.794, and the equivalent penstock would have a uniform diameter of 0.870. This is, of course, true only when the slope of the penstocks are constant.

If the slope is uniform, the per cent of saving in weight in using the economic penstock instead of the equivalent penstock is given in the fourth column. For example, if the lower plates of the economic penstock are 1¼-in. thick, the saving in weight of steel will be 4.6 per cent. If the lower sections of the penstock are on a flatter slope than the upper part of the penstock, the saving in weight will be greater than that given in the table.

TABLE OF RELATIVE DIAMETERS

Thickness of Plate, in.	Relative diameter for minimum weight	Equivalent penstock of uniform diameter	Saving in weight, per cent
1/4	1.000	1.000	0.0
5/16	0.963	0.991	0.5
3/8	0.935	0.978	1.2
7/16	0.911	0.965	1.6
1/2	0.891	0.952	2.0
9/16	0.874	0.939	2.4
5/8	0.858	0.927	2.7
11/16	0.845	0.916	3.0
3/4	0.833	0.906	3.3
13/16	0.822	0.896	3.6
7/8	0.812	0.887	3.8
15/16	0.802	0.878	4.0
1	0.794	0.870	4.1
1 1/16	0.786	0.863	4.3
1 1/8	0.778	0.855	4.4
1 3/16	0.771	0.848	4.5
1 1/4	0.765	0.842	4.6

The economic penstock does not require as thick plates for the lower courses as the equivalent penstock of uniform diameter. It can, therefore, deliver a greater amount of power for a given thickness of the lower plates. For example, the thickness of the lower plates of the penstock of constant diameter, equivalent to the economic penstock whose lower plates are 1¼ in. thick, is 1⅜ in. If 1¼ in. is the maximum thickness to be allowed, then the largest penstock of constant diameter will be 10/11 of the required diameter and its capacity will be only 79 per cent of that of the penstock with the varying diameter.

EXAMPLE

Determine the economic diameters of a riveted steel penstock which will discharge 500 sec.-ft. 4 hr. per day, 400 sec.-ft. 4 hr. per day, 300 sec.-ft. 6 hr. per day and 200 sec.-ft. 6 hr. per day. Assume steel at $0.05 per pound, power lost in frictional resistances as worth $25 per horse-power-year, interest and depreciation 10 per cent per annum, overweight 10 per cent and the value of c as 100. Assume the thinnest plates as ¼ in., and that the plates will advance in thickness by eighths of an inch.

Substituting in equation (4), using t = ¼, the economic diameter for this thickness is found to be about 129.5 in. From the table the diameters of the other thicknesses may be found by proportion.

Thickness in inches...	¼	⅜	½	⅝	¾
Diameter in inches...	129.5	121	115.5	111	108
Thickness in inches...		⅞	1	1⅛	1¼
Diameter in inches...		105	103	101	99

If this penstock was on a uniform grade the equivalent penstock of constant diameter would be about 109 in., its lower plates would be 1⅜ in. thick, and it would require about 4.6 per cent more steel to construct it.

PROOF OF ADAMS' THEOREM

From the formula for thin pipes under internal pressure,

$$t = 0.217hd/Se$$

S is the allowable unit stress in the steel and e is the efficiency of the riveted joint. Substituting in equation (1),

$$C = 2.32ard^2h(1+n)/Se \text{ dollars} \qquad (5)$$

If any one section of the penstock is considered, it will be noticed that all of the factors in the equation except d are constant. The equation may therefore be written

$$C = Md^2 \qquad (6)$$

in which M is a constant.

Similarly equation (3) may be written,

$$L = N/d^5 \qquad (7)$$

Adding equations (6) and (7) to get the total annual cost, and equating the first derivative with respect to the diameter to zero to determine the condition for minimum cost,

$$N/d^5 = 0.4Md^2$$

This equation verifies the theorem stated by A. L. Adams in the "Transactions" of the American Society of Civil Engineers, Vol. 59, page 177: "That pipe fulfills the requirements of greatest economy wherein the value of the energy lost in frictional resistances equals four-tenths (0.4) of the annual cost of the pipe line."

In the proof of this theorem it was assumed that the cost is proportional to the weight of the metal and that the loss of head due to frictional resistances varies as the square of the velocity of the water in the penstock. Both of these assumptions are fairly well satisfied in the case of riveted-steel pipe. The theorem does not apply to wood-stave or to cast-iron pipe.

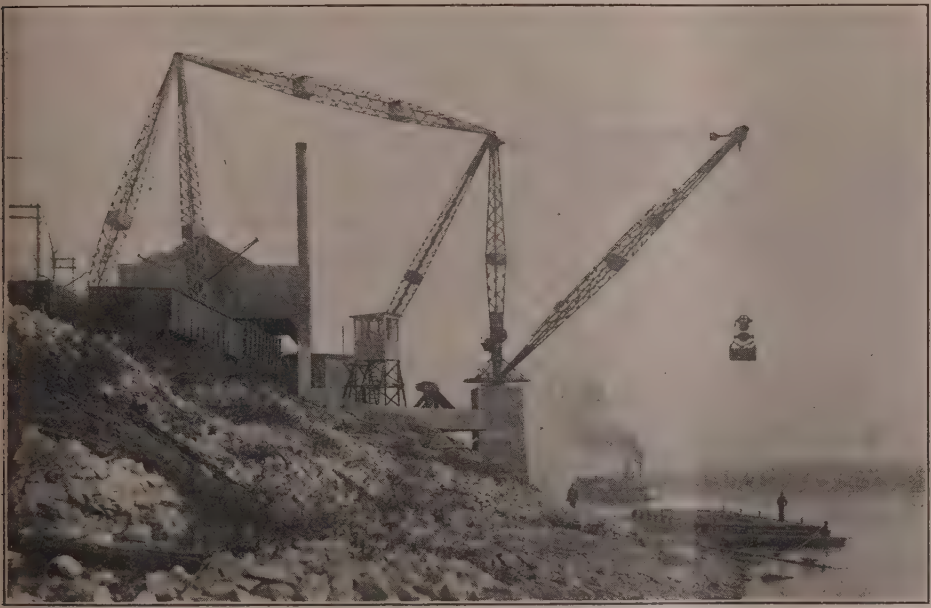
GAGING APPLIANCES at sewage works to enable accurate information to be obtained of the amount of sewage dealt with and for the proper separation of sewage proper and storm flow are recommended in the 1914 report of Hugh Stowell, chief inspector of the Mersey and Irwell Joint Committee, England. Without such information, Mr. Stowell says, satisfactory control of the works and the accurate fixing of the levels of overflow sills are difficult, and controversy is often raised over the relative proportions dealt with as sewage and storm water. In a few cases such appliances have been provided, but their more general adoption is very desirable, and it would be of great assistance if the Local Government Board insisted on their provision before sanctioning sewage-disposal schemes of any considerable size. The Royal Commission on Sewage Disposal makes an important recommendation on this matter in its eighth report.

Sand-Handling Plant for Variable-Tide Levels

Mississippi Sand Company Has Installed at Alton, Ill., Stiffleg Derrick, Clamshell Bucket and Concrete Bins

By E. C. REEDER

THE Mississippi River in the vicinity of St. Louis, Mo., is subject to wide fluctuations in water level and any plant which must handle materials from barges floating in the river to railway cars or wagons on the bank must be designed to take care of this wide fluctuation in level either by constructing inclined tracks which are submerged by the water and upon which a portable plant can move, or by building a pile or crib structure in deep water. In either case there is always a possibility of the ice run in the spring doing a good deal of damage. The location of the Mississippi Sand Company a few miles up the river from St. Louis at Alton, Ill., is particularly fortunate in this respect. The plant is located on a rock ledge which juts into the river, and deep water is to be had at all stages of the river with very little variation in the shore line.



ARRANGEMENT OF SAND-HANDLING PLANT FOR VARYING TIDE LEVELS

The plant consists of a steel derrick which operates a clamshell bucket discharging into a concrete bin underneath which the railway cars pass. The bucket gathers its load from the decks of barges on which the sand from the river bottom is pumped by hydraulic dredges. The derrick is of the stiffleg type, the mast being set upon a concrete pier 40 ft. high founded on bedrock. Two reinforced-concrete struts from the base of the mast tie the bins and the engine and stiffleg foundations to the center pier and counteract the overturning moment on the high center pier due to the weight of the bucket and load at the end of the boom. The mast of the derrick is 57 ft. high and the boom is 74 ft. long. One stiffleg is carried up to the top of an A-frame and acts as a horizontal strut, the boom swinging underneath over the top of the bins. This derrick is equipped with a 14-ft. diameter bullwheel and all the working sheaves are 36 in. in diameter, bronze-bushed, operating on 3-in. diameter pins, center-bored for grease cups. The derrick itself is unusually heavy in construction.

The bucket itself is the Hayward Company's manufacture, of 2½ cu. yd. capacity, Class G, with ore bowl. The bucket is closed by a tackle arrangement, the operating lines passing over a series of sheaves in the upper head and lower centers of the bucket, the dead ends of the operating lines being fastened to the end of the boom; the bucket thus operates in the bight of the line. All the bucket sheaves are made of manganese steel.

The plant is steam operated, the bucket engine being of Lidgerwood manufacture, with double 12 x 12-in. cylinders and two friction drums arranged tandem. The drums are 3 ft. in diameter and are equipped with cork insert frictions. The swinging engine has 6¼ x 8-in. cylinders and is compound geared to a single drum 20 in. in diameter. The engines are arranged for remote control, the operating levers being carried up to the pilot house located on the roof of the engine house, where the operator has a clear view of his work.

As it is not necessary to change the radius of the boom except at rare intervals, the topping lift is therefore connected to a hand winch attached to the mast just above the bullwheel.

Steam for the plant is furnished by a 100-hp return tubular boiler, and the usual auxiliaries, such as car-spotting engine, pumps, etc., are provided.

The sand bin itself is 36½ x 38 ft. in plan, and is 30 ft. high above the railroad track, with a working clearance of 17 ft. 8 in. over the railroad tracks. The foundation itself is a solid block of concrete, designed as a flat slab 41 ft. square and 21 in. thick and rests on an old fill consisting of earth and spalls of limestone from a nearby quarry. Nine columns, 2 ft. 4 in. square, support the bin, which consists of a flat floor 18 in. thick with 9-in. walls, the whole structure being heavily reinforced.

The average capacity of this plant is about 1000 cu. yd. of sand per day, while a great deal more can be handled if necessary. The barges are towed into the landing place at the foot of the derrick and unloading commences at the downstream end, the barge being let down the stream by paying out on the ropes as unloading progresses.

Paving Reservoir Slopes

THE large dikes of the Ashokan reservoir for the New York City water supply from the Catskills have earth slopes, protected on the upstream surface by about 95,000 cu. yd. of pavement or riprap extending to 6 ft. above high-water level.

The pavement is made of flat local stones laid on edge in order that the expansion due to weathering may tighten the joints instead of injuring the exposed surface, as would be the case if the stones were laid flat. The specifications require the pavement to be made of sound, durable stone bedded in crushed stone, with even flat faces placed with bedding plane normal to the surface of the paving. Fine-grained stones are not satisfactory. In general stones acceptable for concrete work are satisfactory. The pavement is usually about 2 ft. thick, with two-thirds of the top layer having a thickness of 16 in. and the remaining third penetrating through the cushion of broken stone to the full depth.

The contract price is $2.50 per cubic yard. The lower portions of the upstream slope are riprapped with durable stone evenly spread in layers from 2 to 6 ft. thick, according to the engineers' directions. This work was done under the direction of Chief Engineer J. Waldo Smith by Winston & Company, contractors.

PAVING SLOPES OF ASHOKAN RESERVOIR DIKE, CATSKILL AQUEDUCT

Efficiency of Various Parts of Coal-Tar Creosote Against Marine Borers

Tests Made by U. S. Forest Products Laboratory on Specimen Pile Sections at Gulfport, Pensacola, San Francisco and San Diego

By CLYDE H. TEESDALE
Engineer in Forest Products, U. S. Forest Products Laboratory, Madison, Wis.

TESTS were undertaken some time ago by the U. S. Forest Products Laboratory with the object of obtaining information on the comparative resistance of various constituents of creosote in protecting wood from the attack of marine borers. Three other preservatives not derived from coal tar were included in the experiments after they had been started. Southern yellow-pine test specimens 2 ft. long and 6 in. in diameter were used, furnished by J. B. Lindsay, general manager of the West Pascagoula Creosoting Company.

The following preservatives, the analysis and physical properties of which are given in Table 1, were used:

Coal-Tar Creosote.—This was a good grade of oil which would pass the 1912 specifications No. 1 of the American Railway Engineering Association, except that it contained a small amount of tar, probably less than 5 per cent.

Fractions 1 to 5 were obtained by redistilling a coal-tar creosote similar to the one described above. Fraction 1 contained distillate passing over until a temperature of 205 deg. C. was reached. Fraction 2 contained distillate passing over between 205 and 250 deg. C. and consisted largely of naphthalene. Fraction 3 contained distillate passing over between 250 and 295 deg. C. Fraction 4 contained distillate passing between 295 and 320 deg. C., and fraction 5 consisted of the residue above 320 deg. C.

The original creosote from which the fractions were redistilled contained some tar. Fraction 5, therefore, was a very heavy, viscous product, containing pitch. It did not flow freely at 15 deg. C. Its viscosity (Engler) varied from 85 at 50 deg. C. to 2.75 at 96 deg. C. The fractions were redistilled in a still 6 ft. in diameter and 24 ft. long. No fractionating column was used.

Water-Gas-Tar Creosote.—This was a very high boiling product of water-gas tar. It was a distillate oil containing no tar.

TABLE 1—PHYSICAL PROPERTIES OF PRESERVATIVES USED IN PILING EXPERIMENTS

Preservative	Specific gravity	Temperature at specific gravity, Centigrade	Flash point, Centigrade	Burning point, Centigrade	Odor	Remarks
Coal-tar creosote	1.048	60	93	100	Strong creosote	
Coal-tar creosote—Fraction 1	0.934	60	62	69	Like toluene	
Coal-tar creosote—Fraction 2	1.003	60	79	85	Strong like naphthalene	Solid at room temperature
Coal-tar creosote—Fraction 3	1.045	60	103	110	Strong coal-tar creosote	
Coal-tar creosote—Fraction 4	1.088	60	130	136	Mild coal-tar creosote	Would not flow at 30 deg. C.
Coal-tar creosote—Fraction 5*	1.150	60	172	178	Mild coal-tar creosote	Residue above 320 deg. C.
Water-gas-tar creosote	1.058	60	48	65	Like kerosene oil	A distillate of water-gas tar, very high boiling
Hardwood tar	1.195	60	90	*..	Disagreeable pyroligneous	*Water boiled off, preventing burning
Timber asphalt	1.063	60	240	260	Like crude oil	A residue of petroleum
Copperized oil	0.937	25	125	164	Like crude oil mild	Contains 0.34 per cent of copper

*Fraction 5 contained about 40 per cent of residue above 380 deg. C., when analyzed by Forest Service method. The residue was solid with conchoidal fracture.

Timberasphalt.—This was a heavy, viscous petroleum product having an asphaltic base.

Copperized Oil.—This was a petroleum product having a paraffine base. It contained 0.34 per cent of copper, probably in the form of a copper soap, which would be soluble in petroleum oils.

Hardwood Tar.—This was a tar produced in the distillation of hardwood. It contained 11.7 per cent of water, probably pyroligneous acid—50 per cent distilled below 244 deg. C., by the Forest Service method.

METHOD OF CONDUCTING TESTS

The first treatments were made with the five fractions and coal-tar creosote. About 18 lb. of oil per cubic foot were injected. After these specimens were installed it was decided that to obtain quick results treatments using 8 lb. per cubic foot should be made. These were installed a year later, together with specimens treated with water-gas-tar creosote, timberasphalt and copperized oil. The average absorptions of preservative are given in the tables showing condition of the specimens.

After treatment the specimens were installed at the following places:

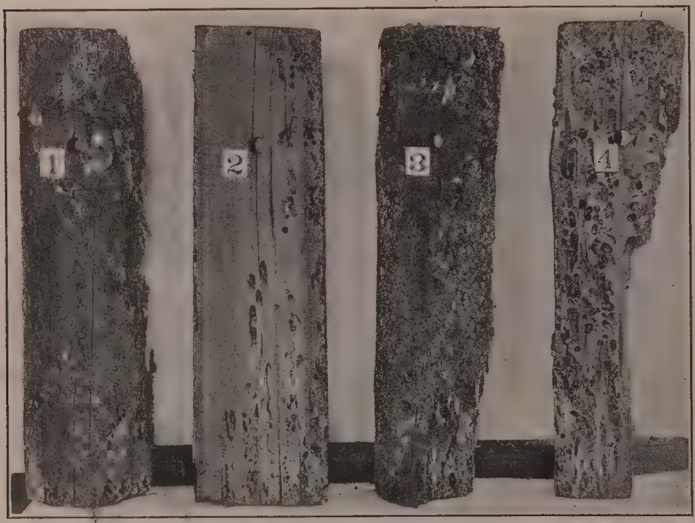
Gulfport, Miss.—Specimens were placed directly in the Gulf of Mexico, in a pier of the Gulf & Ship Island Railroad. Very little fresh water enters near this point.

Pensacola, Fla.—Specimens were first placed in the Pascagoula River 1 mi. from its mouth, at Gautier, Miss. Large volumes of fresh water in the river, however, prevented severe attack even on untreated specimens and they were moved to Pensacola, Fla., and placed in the Commendencia Street Wharf of the Louisville & Nashville Railroad.

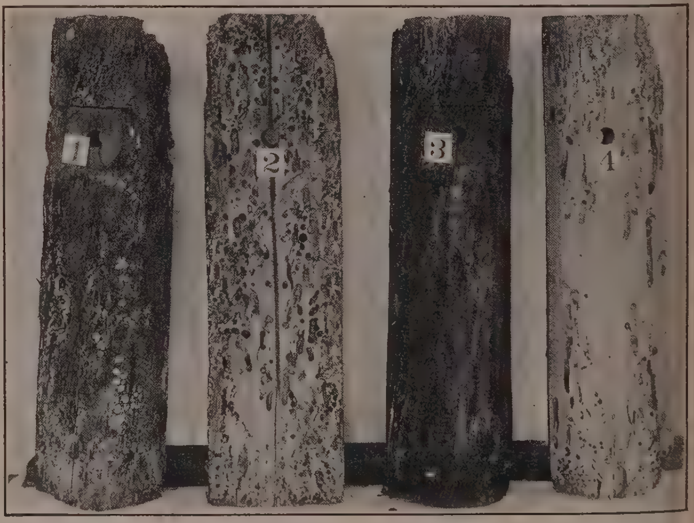
Fort Mason, Cal.—Specimens were installed in San Francisco Bay, well out toward the Golden Gate. At this place there is no intervening land to cut off the direct flow of the sea, which probably makes the conditions more favorable for the attack of shipworms.

San Diego, Cal.—Specimens were placed under the East Santa Fe wharf in San Diego Bay, where the attack of limnoria is especially severe.

The specimens were mounted on galvanized-iron rings, six or seven to the ring. The rings were suspended at various depths between the surface and the mud line to obtain information on the effect of depth of water on the severity of attack. A depth of from 10 to 12 ft. was chosen when possi-



SPECIMENS TREATED WITH FRACTION 2, AFTER 24 MONTHS' SERVICE AT GULFPORT—1 AND 3 SHOW OUTSIDE APPEARANCE; 2 AND 4 ARE LONGITUDINAL SECTIONS



SPECIMENS AFTER 9 MONTHS' SERVICE AT GAUTIER AND 13 AT PENSACOLA—1 AND 2, SPECIMENS TREATED WITH FRACTION 1; 3 AND 4, TREATED WITH FRACTION 2 ble. Four specimens were treated with each preservative, and each specimen of a treatment was mounted at a different depth.

The specimens were examined at intervals of at least one year. Tables 2 to 6 show their condition at the last inspection made during January to March, 1914.

The attack at Gulfport and Pensacola was principally by xylotrya gouldi. No evidence was found of limnoria attack on the test specimens at either location. The borers were frequently found alive and working in the treated specimens when they were examined. In the case of the lighter fractions of creosote, the attack was principally on the surface, extending in from ½ to ¾ in. This indicates that part of the preservative may have been washed out of the outer portions of the wood. The lighter fractions, 1 and 2, were not efficient in preventing attack, even in the case of heavy treatments, while Fraction 5 and coal-tar creosote practically prevented attack even in the case of the light treatments.

TABLE 2—RESULTS AT GULFPORT AFTER 22 MONTHS' SERVICE

Preservative	No. of specimens	Average absorption, lb. per cu. ft.	Condition* Slight attack	Medium attack	Severe attack	Destroyed
Coal-tar creosote...	4	8.5	4	..	..	..
Fraction 1.......	4	8.5	..	..	2	2
Fraction 2.......	4	6.4	..	..	2	2
Fraction 3.......	4	7.4	1	3	..	..
Fraction 4.......	4	9.9	3	1	..	..
Fraction 5.......	4	8.9	4	..	..	..
Water-gas-tar-creosote	4	7.5	3	1	..	..
Timberasphalt	4	10.0	..	..	..	4
Copperized oil	4	10.0	..	..	..	4
Hardwood tar	4	11.9	..	..	1	3
Untreated	8	..	..	..	..	8

*Subject to attack of shipworm only.

TABLE 3—RESULTS AT PENSACOLA AFTER NINE MONTHS' SERVICE AT GAUTIER, WHERE THE SPECIMENS WERE NOT ATTACKED, AND 13 MONTHS AT PENSACOLA

Preservative	No. of specimens	Average absorption, lb. per cu. ft.	Condition* Slight attack	Medium attack	Severe attack	Destroyed
Coal-tar creosote ..	3	10.7	2	1	..	..
Fraction 1	3	8.5	..	1	1	1
Fraction 2	3	5.3	..	1	1	1
Fraction 3	3	6.8	..	2	..	1
Fraction 4	3	7.0	2	1	..	..
Fraction 5	3	8.0	3	..	..	..
Untreated	3	..	..	..	..	3

*Subject to attack of shipworm only.

TABLE 4—RESULTS AT PENSACOLA AFTER 23 MONTHS' SERVICE AT GAUTIER, WHERE THE SPECIMENS WERE NOT ATTACKED, AND 13 MONTHS AT PENSACOLA

Preservative	No. of specimens	Average absorption, lb. per cu. ft.	Condition* Slight attack	Medium attack	Severe attack	Destroyed
Coal-tar creosote ..	4	20.7	3	1	..	..
Fraction 1	4	17.7	..	..	4	..
Fraction 2	4	18.5	..	..	4	..
Fraction 3	4	16.7	..	2	2	..
Fraction 4	4	18.2	4	..	..	..
Fraction 5.......	4	14.2	4	..	..	..
Untreated	4	..	..	..	..	4

*Subject to attack of shipworm only.

TABLE 5—RESULTS AT SAN DIEGO, AFTER 23 MONTHS' SERVICE

Preservative	No. of specimens	Average absorption, lb. per cu. ft.	Condition* Slight attack	Medium attack	Severe attack	Destroyed
Coal-tar creosote ..	4	7.6	2	2	..	..
Copperized oil	4	8.8	1	1	2	..
Water-gas-tar creosote	4	6.3	2	2	..	..
Hardwood tar	4	6.1	..	1	2	1
Timberasphalt	4	8.9	..	1	2	1
Untreated	4	..	..	..	..	4

*Subject to attack of limnoria and shipworm.

At San Diego and San Francisco Bay there was considerable attack by limnoria lignorum. Xylotrya gouldi were also present. The limnoria works much slower than the shipworm on untreated wood. It is rather difficult to determine, in general, which does the greater damage to treated wood. In these two locations the greater damage was done by limnoria to the treated specimens. In most cases the shipworm did not attack the specimens treated with Fraction 3, 4 or 5, or the specimens treated with coal-tar creosote or water-gas-tar creosote. Limnoria were present to some extent in all of the specimens. At Gulfport and Pensacola the shipworm was found in all specimens, and the damage done on the treated specimens was much greater than that accomplished by limnoria in the Pacific Coast specimens. It would seem from these results that the treatments with most of the preservatives were more efficient in preventing the combined attack of shipworm and limnoria at San Diego and San Francisco than in checking the shipworm at Pensacola or Gulfport.

TABLE 6—RESULTS AT FORT MASON, AFTER 37 MONTHS' SERVICE

Preservative	No. of specimens	Average absorption, lb. per cu. ft.	Condition* Slight attack	Medium attack	Severe attack	Destroyed
Coal-tar creosote ..	4	20.8	4	..	..	..
Fraction 1	4	18.5	..	4	..	..
Fraction 2	3	18.4	..	2	1	..
Fraction 3	4	19.4	4	..	..	..
Fraction 4	4	18.1	4	..	..	..
Fraction 5	4	16.0	4	..	..	..
Untreated	4	..	..	..	..	..

*Subject to attack of limnoria and shipworm.

TABLE 7—SUMMARY OF TESTS

Preservative	No. of specimens	Condition Slight attack	Medium attack	Severe attack	Destroyed
Coal-tar creosote.	19	15	4	..	..
Fraction 1....	15	..	5	7	3
Fraction 2....	14	..	3	8	3
Fraction 3....	15	5	7	2	1
Fraction 4....	15	13	2	..	..
Fraction 5....	15	15	..	..	..
Copperized oil...	8	1	1	3	3
Water-gas-tar creosote	8	5	3	..	..
Hardwood tar ..	8	..	1	2	5
Timberasphalt ..	8	..	..	3	5
Untreated	23	..	..	..	23

In general Fraction 5 was the most efficient preservative. Specimens treated with this oil were practically sound in every case. Coal-tar creosote, water-gas-tar creosote, and Fraction 4 were also very efficient in preventing attack. Most of the specimens treated with these preservatives showed only slight evidences of attack. Those treated with Fraction 3 were attacked to a considerable extent in the Gulf locations and to a slight extent on the Pacific Coast. Specimens treated with Fractions 1 and 2 were in most cases in bad shape. Fraction 2 was the least efficient of the five fractions. This is a very interesting feature of these experiments, because this fraction consisted largely of naphthalene.

The treatment with hardwood tar was of very little value. A slight degree of resistance only was noted. Timberasphalt was of no value whatever in the Gulf waters, but seemed to offer slight resistance on the Pacific Coast. Copperized oil showed some resistance to attack by borers, and in view of the result obtained from timberasphalt it is believed that an admixture of copper in an oil will increase its resistance to the attack of borers.

Untreated specimens were destroyed in less than a year at Gulfport and Pensacola. At San Diego they lasted between ten and eighteen months, and at San Francisco about two years.

There seemed to be little difference in the intensity of attack at various depths. Those at the surface were perhaps slightly less severely attacked than those set at the mud line.

The following preservatives showed considerable efficiency in preventing attack by marine borers: Fraction 4, water-gas-tar creosote, coal-tar creosote and Fraction 5. The following preservatives were much less efficient in retarding attack: Timberasphalt, copperized oil, hardwood tar, Fraction 1, Fraction 2 and Fraction 3.

The derivatives of coal tar, having the higher specific gravity and the higher amounts of high boiling compounds, were the most efficient in retarding attack.

Naphthalene, when used by itself, did not prevent attack by borers.

Conditions at San Diego and San Francisco are less severe than those at Pensacola or Gulfport. Attack by shipworms at the latter places caused greater damage to treated specimens than the combined attack of limnoria and shipworms at the former locations.

Sanitation in Labor Camps

Rules and Regulations Established by the New York State Department of Labor, in Effect June 1

RULES and regulations for the sanitation of living quarters in labor camps have been promulgated by the New York State Department of Labor. While they apply particularly to conditions in cannery camps, they may contain information of interest to contractors on engineering construction. Some of the more important provisions are given below.

The roof and the walls of living quarters must be watertight.

In new structures the floor of every room used for sleeping purposes must be built of wood, asphalt or concrete with smooth finish of non-absorbent cement; if built of wood, it must be raised at least 1 ft. from the ground and the boards used must be planed, tongued and grooved and at least ⅞ in. in thickness; if built of asphalt or concrete, it must be laid on a solid foundation other than earth, and must be at least 2 in. in thickness. In existing structures the floor, if built of wood, must be raised above the ground a sufficient distance to allow free circulation of air beneath it.

In every room used for sleeping purposes there must be provided not less than 400 cu. ft. of air space for each person, except that not less than 200 cu. ft. may be provided for each child under 14 years of age. All living quarters other than tents must be built with windows. Every room must have at least one window opening directly to the outer air. Every window must be set with glass and so constructed that it can be easily opened. Every window opening must have an area of at least 4 sq. ft. and must be at least 1 ft. high. Every window opening must be protected by mesh, wire netting or other screening to prevent the entrance of any person, but not to interfere with the free circulation of air. In every existing room used for sleeping purposes having not more than one window a transom opening not less than 2 ft.x6 in. must be cut to the outer air. In every structure hereafter erected, unless ventilation through the roof is provided, there must be a window or door opening in at least two walls of every room, one of which may open upon a hall or passageway opening to the outer air.

There must be maintained in connection with all living quarters kitchen and dining-room accommodation under shelter, which shall have seats for at least 50 per cent of all persons dwelling in such living quarters, who are not otherwise provided with such accommodations under shelter separate from their sleeping rooms.

Beds, cots or bunks must be provided in every room used for sleeping purposes, in sufficient numbers for the occupants of the room. Every such bunk must be raised at least 12 in. from the floor. No bed or bunk may be placed one above the other. No bunk may be placed at any time nearer than 2 ft. from the side of any other bed, cot or bunk in the same room.

Water must be supplied for drinking and washing purposes in every camp. It must be obtained from a source and in quantities satisfactory to the Commissioner of Labor. Every employer must furnish such water at the living quarters provided for his employees. Where there is no stream or lake accessible for bathing, and no baths are provided for the use of the camp, shacks or sheds, separate for each sex, removed from each other, and at all times accessible, must be provided for bathing purposes. Tubs and water for laundry purposes must be provided in or adjacent to all living quarters.

Wear of London Sewers

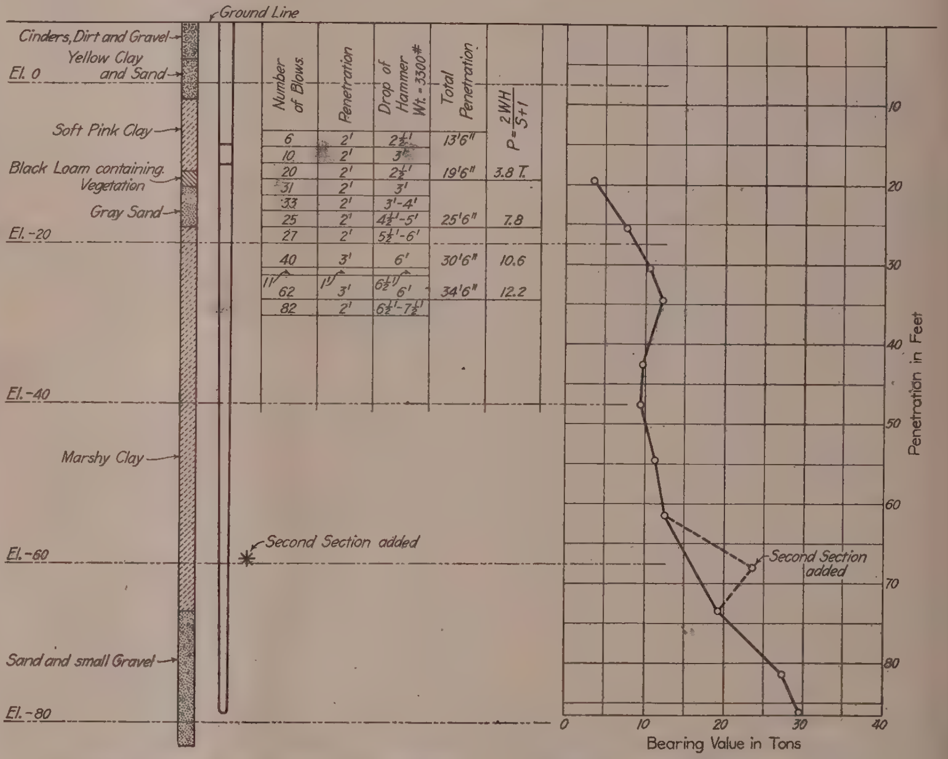
THE original large sewers of London, England, according to information from the chief engineer of the London County Council in a recent U. S. consular report, were constructed of local bricks known as London stocks, set in lime mortar or sometimes in Roman cement. An egg-shaped sewer 3 ft. 9 in. x 2 ft. 6 in. constructed about 60 years ago of good bricks and hard-setting lime mortar has recently had to be repaired, as the invert was worn to a depth of 4½ in. The velocity in this sewer ranged between 3 and 7 ft. per seccond. Later sewers of these bricks and Portland-cement mortar have been 50 years in use and are in good condition, though the inverts are rather rough owing to the unequal wear of the bricks. When the main drainage of London was undertaken about 1856, careful inquiries were made as to the most suitable bricks to use, and those made from the gault, a tenacious blue clay lying between the upper and lower green sands under the chalk, were selected. Nearly the whole of the original main drainage works of London were built of these bricks, which are strong and durable, with smooth surface and regular shape. The sewers have now been in use about 50 years and are in excellent condition, though slightly worn on the invert. The velocity in them varies from 3 to 4 ft. per second in dry weather to 5 to 6 ft. during rain.

Milwaukee Track-Elevation Foundation Tests

Unusual Soil Conditions Encountered by Chicago, Milwaukee & St. Paul Hamper Its Grade-Separation Work in Milwaukee

AS a result of the unusual geological conditions encountered in its track-elevation work at Milwaukee, the track-elevation department of the Chicago, Milwaukee & St. Paul Railway has found it necessary to make a great number of preliminary foundation tests.

The district over which the work extends runs from Kinnickinnic Avenue to West Water Street, with a variable right-of-way, and covers what was formerly (about sixty years ago) an impassable marsh. In fact, the railroad tracks were first laid on a trestle on account of the excessive softness of the soil. Of recent years the track has been filled in and industries along the right-of-way have been built on made ground.



Number of Blows	Penetration	Drop of Hammer Wt. = 3300#	Total Penetration	$P=\frac{2WH}{S+1}$
6	2'	2½'	13'6"	
10	2'	3'		
20	2'	2½'	19'6"	3.8 T.
31	2'	3'		
33	2'	3'-4'		
25	2'	4½'-5'	25'6"	7.8
27	2'	5½'-6'		
40	3'	6'	30'6"	10.6
11' 62	1' 3'	6½' 6'	34'6"	12.2
82	2'	6½'-7½'		

RECORD KEPT ON LAYOUT PLAN, WHICH IS PLOTTED ON CROSS-SECTION PAPER

Little or no information concerning the soil conditions was on hand when the work was started. Since then foundation conditions on all the buildings in the area affected have been obtained by the engineers. The soil was found to be peculiar and tricky, varying considerably in 100 ft. In one case a building was found that had 30-ft. piles at one end and 70-ft. piles at the other.

Test Borings and Piles

The plans call for fourteen subways and twenty retaining walls, and at each subway an average of three test borings was made. These borings were carried down from 75 to 80 ft. A 3-in. casing pipe and ordinary well-builder's auger were used. The casing pipe was driven by a small Arnott steam hammer. The borings were taken down through an average of 60 ft. of peaty marsh material, when sand and gravel were struck. About 20 ft. of sand and gravel were then encountered. When this depth was penetrated without striking hardpan it was found impossible to go further economically. To determine what was below this point the company contracted to have four borings made. The contractor employed the core-drilling method, using a nest of pipe, starting with a 10-in. casing at the top and tapering to a 4-in. pipe at the bottom. The first bore cost about $2.25 per linear foot, and the others $2.50 per linear foot. They were carried down to a maximum of 115 ft. About 95 ft. down a stiff blue clay was found. The conditions described in the foregoing were the average conditions. In some places the stiff clay was found directly under the marsh.

Test piles were driven to check the borings for each retaining wall and subway. An average of three test piles was driven in each case so as to come within the footings of the future structures.

Single piles were first loaded with 15 tons of pig iron, the load being increased to as high as 40 tons on one pile. A typical test pile showing soil conditions at various depths, together with the record kept, is shown, as is the bearing-value curve.

Equipment

About 15,000 piles of an average length close to 75 ft. are to be driven. The three-track drivers now used in driving the piles have 63-ft. leads, and one is being built with an 80-ft. lead. An Orton & Steinbrenner locomotive crane is used in handling the piles and a No. 1 Arnott steam hammer for driving them. Where especially long piles are needed, running up to 80 ft., a pile about 56 ft. long is driven and another pile spliced to it with a section of wrought-iron pipe 3 ft. long. A pile inspector is placed with each driver, and he makes a report each day, giving the bearing power, penetration, and other notes on every pile driven. Unit costs are being kept on the work.

A decision was recently reached to elevate for four main tracks within the limits of the elevation. At present the company has only two main-line tracks for all passenger and freight traffic. The foundation work is fast nearing completion and work on the subways and retaining walls will be started in the near future. A. Daniels is the assistant engineer in charge of construction and H. Wuerth is resident engineer on the work.

Fresh Water and the Teredo

Attack on Hull of Government Snagboat Indicates That the Borer Lives and Thrives Far from Tidewater

AS it seems to be the popular belief that the teredo can exist only in sea and tidewaters, and that its transfer to fresh water would result in its death, R. G. McGlone, in the July-August issue of the "Professional Memoirs," Corps of Engineers, U. S. A., describes an experience to the contrary.

The U. S. snagboat "Waco" was built at Jeffersonville, Ind., the hull being constructed of longleaf yellow pine, except the rake planking, which before launching was painted with carbolineum. All rake planks were of oak.

As soon as the vessel was completed she started on the trip from Jeffersonville to the Brazos River, spending, altogether, two and one-half months in tidewater, including the time spent in snagging the Brazos below Mile 40. The effect of the tide is perceptible up to this point, although there is no sign of barnacle or teredo life above Mile 20.

After passing Mile 40 the "Waco" spent the next two years and ten months working her way upstream to Mile 171, from which point she was recalled and hauled out for repairs. An examination of the hull planking proved it to be fairly well honeycombed by the teredo, necessitating the renewal of all bottom planking and the greater portion of the gunwales.

Some of the specimens of the teredo that were examined were ¾ in. in diameter and 18 in. long, all alive and healthy at the time planks were removed.

The following analysis of Brazos River water, taken at Mile 418, shows a high percentage of salt, an amount 18.7 times that contained in samples taken from the Guadalupe River:

Ingredients	Parts per million
Iron and alumina	11.00
Silica	162.10
Calcium carbonate	460.50
Magnesium sulphate	120.00
Sodium sulphate	463.60
Sodium chloride	770.48
Alkalinity equals sodium hydroxide	14.00

It is possible that the gradual transfer of the "Waco" from salt water to fresh water, together with the natural saltiness of the river, has been a factor in preserving the life of many of the teredos that had worked into her planks.

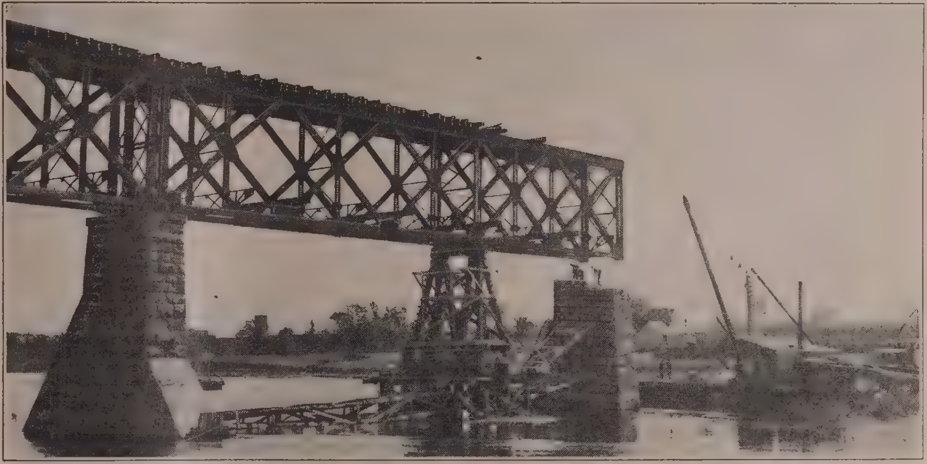
There is no doubt that the specimens were genuine teredos, as they showed all the characteristic features, and the holes left by them were lined with calcareous matter.

THE ATLANTIC CITY PIPE LINE, which was mentioned in a note on page 186 of this journal of Aug. 15, 1914, with reference to signs painted thereon, is built of cast-iron and not of steel, as stated in that note. The pipe was supplied by the United States Cast Iron Pipe & Foundry Company.

Rebuilding Ice-Wrecked Bridge

Piers Were Removed and Replaced and Superstructure Was Recovered, Re-erected and Aligned in Six Months, Saving Cost of New Bridge

ICE wrecked the single-track deck bridge of the Montreal & Southern Railway across the St. Francois River near Pierreville, Quebec, Canada, during the winter of 1912-1913. Three spans were carried away, two piers were destroyed, a third pier was badly damaged, two more piers were twisted, and one of the remaining spans was displaced. Successive falsework towers were built for the temporary supports of one span while its damaged pier was replaced; the other piers were rebuilt and the superstructure was recovered, re-erected and aligned in six months, thus saving and restoring the old bridge instead of building an entirely new structure.



SECOND TEMPORARY SUPPORT OF SPAN—DAMAGED PIN BEING REMOVED

The bridge has seven 125-ft. riveted truss spans supported on masonry piers with pile foundations. Three of the piers were completely turned over, and two of them were seriously twisted and displaced. The sixth was very badly damaged by scour, which exposed the upper 10 ft. of the foundation piles and destroyed the support on one side of the pier, allowing the shaft to become inclined 8 ft. from the vertical at the top, thus assuming an unstable position, in which it was maintained only by the resistance afforded by the superstructure still supported on it.

Operations were commenced May 15, 1913, by the construction of a temporary support which carried one end of the 125-ft. span and allowed its inclined unstable pier to be removed and rebuilt. As the condition of the old pier was too precarious to permit pile-driving adjacent to it, a 20 x 30-ft. timber crib about 10 ft. high was built on shore, launched, floated to position, filled with stone and sunk to the bottom under the span about one-third of the distance from the inclined pier to the uninjured pier which supported the opposite end of the span. A 12-post vertical timber tower framed into the crib projected a few feet above the surface of the river and was X-braced and covered with a platform on which cribbing was built, and an upper tower consisting of eight inclined 12 x 12-in. posts was erected at the second panel point from the end of the bridge, where it supported both top and bottom chords.

Computations were made verifying the efficiency of the truss to act as a cantilever fulcrumed on the tower two-thirds of the distance from the anchor end to the extremity. In order to provide lateral supports for the inclined damaged pier and to prevent its collapse when the resistance offered by the superstructure was removed, horizontal timber bracing was inserted between it and the falsework tower, and was continued from the latter to the adjacent uninjured pier by trussed horizontal bracing shown in the photograph, which provided continuous transverse resistance.

FALSEWORK FULCRUM TOWER

Jacks of a combined capacity of 150 tons were installed on top of the crib tower, engaging the stiff bottom chords at the panel points, and were operated to lift the ends of the trusses clear of their seats on the damaged pier, and the pier masonry was removed. Immediately thereafter foundation piles were driven between the pier site and the cribs, and were capped to receive a three-bent timber falsework tower located under the first panel point from the projecting end of the old span. The bearing on the crib tower was then slacked off, permitting the fulcrum bearing to be transferred to the pile tower, which afforded ample security for maintaining the superstructure in safe position without settlement during the construction of the new pier, and permitted the crib and crib tower to be removed.

The débris of the other wrecked piers was removed as far as necessary. Additional piles were driven, and new piers built as required. Operations were carried on by the aid of a service track installed on a pile trestle constructed alongside the bridge and by a floating equipment of derricks and material scows.

The wrecked superstructure was recovered, separated, repaired where necessary, and re-erected on pile falsework constructed where the new piers were being built. To restore it to alignment, the displaced span was moved 8 ft. transversely by means of hydraulic jacks, which pushed it over greased rails. The work was completed Nov. 12, 1913, thus complying with the requirements that all the débris should be removed before Jan. 1, 1914. The work was executed under the direction of George H. Burgess, chief engineer for the railway. The Foundation Company, Ltd., was the contractor. H. B. Kelsey was superintendent in charge of construction.

Report on Condition of Famous Chicago Road

Engineers Find that Sheridan Road Is Too Narrow, Its Ravine Grades Are Too Steep in Places and Many Jogs and Turns Should Be Eliminated

MAINTENANCE, improvement and reconstruction of Sheridan Road, a 23-mi. highway between Chicago and Lake Forest sustaining a traffic 80 per cent of which consists of automobiles, form the subject of a report by P. E. Green and W. W. Marr, consulting engineers, of Chicago, to the Sheridan Road Improvement Association, an organization of property owners. As a result of the report and efforts of this organization, the Lincoln Park Commission is taking hold and is handling such improvements as are made, the legislature having passed the necessary enabling acts. Although the report was submitted some time ago it has just been made available for publication.

While the road is a popular drive, its condition in many places is such that tourists are avoiding it, due to the destruction caused by the automobile traffic. Generally the road is too narrow, the ravine grades are too steep in some places and there are many jogs and turns to be eliminated. The seven municipalities through which the road passes have made efforts to keep the road in repair, but from end to end it is in a state of unstable equilibrium. The question is further complicated by the width, varying from 40 ft. in southern Evanston to 16 ft. north of Fort Sheridan. The Sheridan Road Improvement Association has in the last three years spent about $6000 for temporary repairs along the lines recommended in this report.

As an example of the need of an intelligent and active organization to guard the best interests of the entire road, says the report, is a new 115-ft. reinforced concrete bridge of 16 ft. width, built at too low an elevation. The grade should have been raised and the width increased to 30 ft. at least.

TRAFFIC CENSUS

To make an intelligent recommendation of a suitable pavement it was necessary to have a concrete idea of the amount and character of the traffic. The census should determine the kind of wearing surface and also furnish a means of estimating future traffic.

A census was taken at four points, three of which covered a period of seven days, from 7.30 a. m. to 12.30 a. m. Station 1 was at the near junction with Ridge Avenue in Evanston; Station 2, at Scott Avenue in Glencoe; Station 3, south of the Moraine Hotel in the northern part of Highland Park; and Station 4, where the record was kept for four days only, was located in Lake Forest.

Fig. 1, showing the method of plotting the segregation and daily variations, is reproduced. At Station 1 the daily traffic varied from 720 on Monday to over 2500 on Sunday, with an average of 1181. At Station 2 the variation was from 480 to 1500, with an average of 667. At Station 3 corresponding figures are from 590 to 1150 and an average of 720, while for the four days at Station 4 the range is from 155 to 375, with an average of 217. In general, automobiles make up 80 to 90 per cent of the traffic. As Station 4 is 32 mi. from Chicago, it is rather beyond the range of an ordinary afternoon pleasure trip, and the traffic is largely of a local nature.

Traffic increase curves (Fig. 3) were prepared for the purpose of estimating the future number of automobiles using the road in 1930. The number of machines in Cook County from 1900 to 1911 was used as the basis because the automobile traffic is 80 per cent of the total, and probably more than 50 per cent were from Cook County rather than the local towns. It was assumed that the traffic increase curve would parallel the curve of the automobile increase. The rate of increase of the number of cars was assumed to decrease regularly until 1920, after which the curve would parallel the population curve.

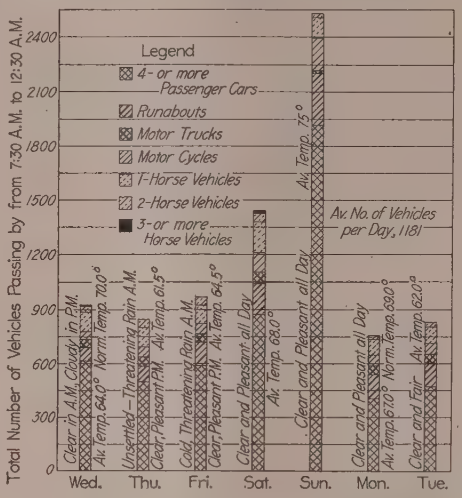


FIG. 1—CENSUS, STATION 1, EVANSTON-WILMETTE, WEEK ENDING AUG. 29

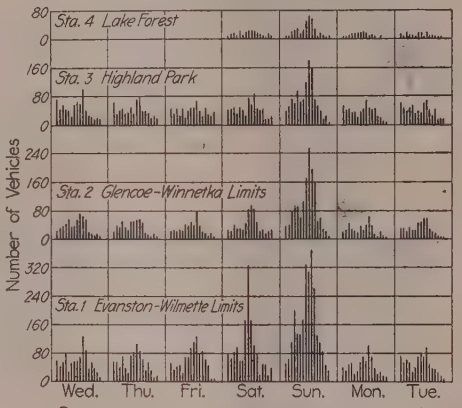


FIG. 2—HOURLY TRAFFIC VARIATION, 7.30 A. M. TO 12.30 A. M.

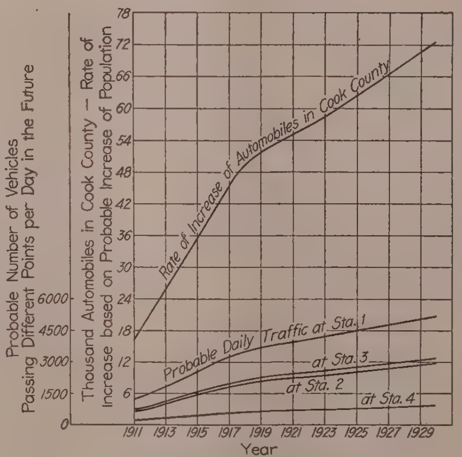


FIG. 3—PROBABLE FUTURE TRAFFIC

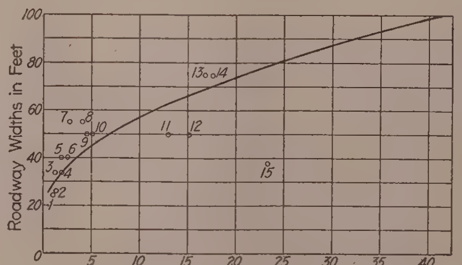


FIG. 4—DIAGRAM FOR DETERMINING ROADWAY WIDTHS

(Numbers denote the stations)

ROADWAY WIDTH

The proper roadway width depends on the amount of traffic. If too narrow, the life of the pavement will be reduced; if too wide, there is needless expenditure. There is no method, according to the report, by which roadway width can be figured accurately from the traffic, due to the wide variation and its elastic and mobile nature.

Figures were sought from the various park boards of the city of Chicago as to traffic and present roadway widths, but only in the case of the South Park Commission were definite amounts of traffic secured. The South Park Commission has taken a traffic census on practically all of its boulevards. These censuses have been plotted up as shown on Fig. 4, and an attempt was made to discover a relation, which, however, is rather indefinite. Nevertheless, a curve has been established which apparently suits most of the cases. This curve is a parabola, and while it is not intended that it should be an iron-bound solution of the roadway width and traffic problem, it does furnish a guide by which the roadway may be determined relatively when used with judgment. The equation for this curve, which was established by trial, is $Y = \sqrt{1/6x + 16}$, in which x is the average number of vehicles per day and Y is the roadway width desired.

From this tentative curve the recommended roadway widths are from Chicago city limits to Winnetka, 40 ft.; to Scott Avenue in Glencoe, 30 ft.; to West Street in Highland Park, 40 ft.; to Lake Forest, 30 ft. There are a few local exceptions.

A 30-ft. roadway may readily be blocked by two teams and an automobile. The recommendation from the curves would give a 40-ft. width at this point. On Michigan Avenue the effect of narrow pavements, where traffic is so congested that vehicles are compelled to follow in the same track, is apparent. The roadway is 50 ft. wide and carries 16,000 vehicles per day. The asphalt surface was six years old and said to be a thoroughly good piece of pavement. North of Twelfth street, where the boulevard has been widened to 75 ft. and the traffic is about 22,000 vehicles per day, there was no sign of rutting in 1911, according to the report, although the pavements were identical and laid at the same time. It is noticed that this year nearly all the asphaltic concrete pavements in Chicago are rutting under the increased traffic.

LIFE OF PAVEMENTS

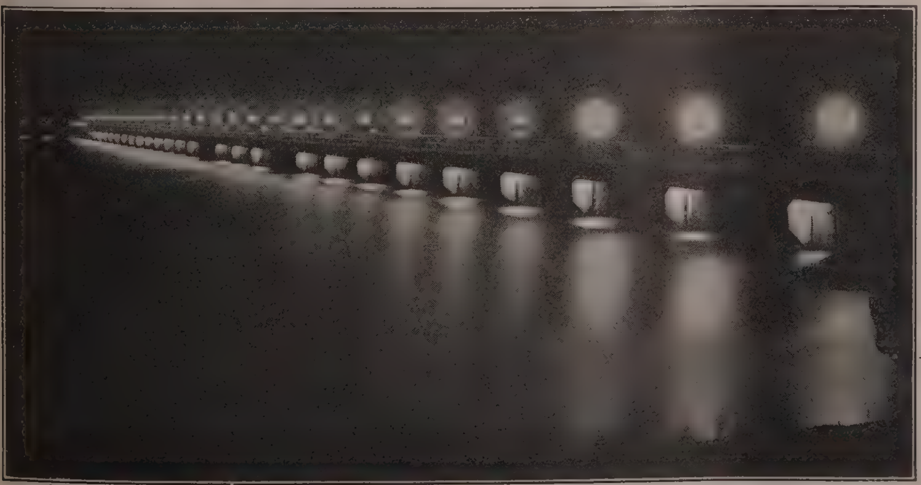
From personal experience and a thorough investigation of the parks and streets in Chicago, and from data from other cities, it was concluded that the following periods of usefulness may be safely assigned to the various pavements, after which it will be necessary to resurface them completely: Bituminous concrete made by the mixing method, 10 years; sheet asphalt (native), 15 years; bitulithic, 15 years; wood block, 25 years; brick, 30 years; concrete, 10 years. These lengths of life refer to Sheridan Road and take into consideration the character of the present and probable future traffic. A qualifying statement is made with reference to the 10-year life assigned to concrete and bituminous concrete to the effect that it is possible an injustice may be done both, but that they have not been in use long enough to demonstrate exactly what life may be expected of them. Bituminous concrete is similar in many respects to the sheet asphalt, and as the asphalt will fail because of the disintegration and evaporation of the chemical constituents of the asphaltic cement, and as a somewhat inferior bituminous product is generally used in this construction, a shorter life was assigned to the bituminous concrete. If a native asphalt is used in making this pavement, a life of 15 years may be assigned to it. The use of such asphalt would increase the cost about 10 per cent.

From reports and approximations given by the various village authorities it was ascertained that about 2 cents per square yard per annum has been spent for repairs to keep the road in its present condition, which cannot be called by any stretch of the imagination first class. About 1 cent per square yard is raised by private subscription. It is estimated that a sum of at least 3 cents per square yard additional is required for proper maintenance.

Illuminating Power Dam

Coon Rapids Structure Lighted Up to Allow Safe Passage at Night

A DAM 2070 ft. long, with a 1000-ft. ogee concrete spillway surmounted by twenty-eight Tainter gates built for the Coon Rapids hydroelectric development, and described in the Engineering Record of Jan. 17, 1914, page 77, has been provided with 100-watt Mazda lamps mounted on gooseneck standards. This illumination, the brilliancy of which is shown in the accompanying photograph, is for the purpose of allowing people to cross safely the bridge over the dam and to facilitate the work of handling the Tainter gates. At certain times of the year, when it is necessary to pass ice or logs, the lighting will facilitate night operations. The development was constructed for the Northern Mississippi River Power Company and is leased to the Minneapolis General Electric Company. It was built by H. M. Byllesby & Company, of Chicago.



COON RAPIDS DAM AT NIGHT, SHOWING BRILLIANCY OF ITS ILLUMINATION

Explosions in Sewers

Study of Action of Gasoline Vapor as Set Forth in Report by O. Hufeland, Assistant Engineer, Department of Public Works, New York

WITH the increase in the use of automobiles throughout the country, and the consequent discharge of large quantities of gasoline from garages, explosions in city sewers have occurred with great frequency. The more recent serious accidents have been those in Pittsburgh, Detroit and New York. The Department of Public Works of the Borough of Manhattan, New York, has studied these gasoline explosions in sewers and the following notes are from a recent report by O. Hufeland, assistant engineer in the office of E. P. Goodrich, consulting engineer of the department.

EXPLOSIVE LIMITS

Experiments made by Eitner in Germany give the mixture of gasoline vapor and air in percentages of volume, indicating the upper and lower explosive limits, as follows: In a 1.9-cu. cm. glass burette—lowest, 2.4 per cent; highest, 4.9 per cent; in a 6.2-cu. cm. cylinder—lowest, 1.10 per cent.

Redwood and Blundstone in England give the following: In a vessel of 1 cu. ft.—lowest, 1.35 per cent; highest, 5.4 per cent.

At the lower limits, or perhaps a little below—say if 1.2 per cent of vapor is mixed with air—a flame will just travel through the mixture. With 1.5 per cent the flame will travel much faster and burn brightly, while with about 2 per cent the movement becomes so fast that the combustion will be explosive and will increase to about 2.6 per cent, when its violence is at the maximum. As more vapor is added, the process is reversed and the combustion will decrease in rapidity until the upper level of about 5 per cent of vapor is reached, when it becomes non-explosive and burns quietly once more. No mixture of air and vapor will burn spontaneously, and all explosions are caused by contact with a flame or an electric spark, but the application of such a flame or spark, however small, will cause ignition.

Laboratory experiments made by Professor Dean of Yale to determine the proportions of liquid gasoline and air that would form an explosive mixture in a closed vessel in which the gasoline was allowed to vaporize indicated that 1 part of gasoline to 5000 parts of air (by volume) exploded violently; that mixtures of 1 to 10,000 and 1 to 15,000 also exploded. A mixture of 1 to 17,143 did not explode, showing that the limit lies between the two latter figures. The gasoline used was 76 deg. Baumé, a better grade than is commercially used.

VOLATILIZATION

Experience justifies the belief that large quantities of gasoline enter sewers from various sources, although analyses of sewage samples often show only very small quantities or even a negative result, the high volatility of the liquid having changed it into vapor. The rapidity of volatilization is very great on its first contact with air and where a thorough mixture of the sewage and the gasoline has not taken place, or where, due to a long run, the gasoline has risen to the surface, it will rapidly turn into vapor. Where the mixture of gasoline and sewage is more complete, or where the presence of soap in the sewage tends to hold the gasoline, the release into vapor is more gradual and is apt to occur for some distance from the point of entrance into the sewer. As the quantity required to form an explosive mixture is very small, beginning, as previously shown, at about 1.2 per cent, the gradual release as above described may either fill the sewer for some distance with a highly explosive mixture or, if the mixture is less rich in vapor, may act as a train to explode a sufficiently rich mixture accumulated at some other point.

As the temperature in the sewers when no steam or very hot water enters is about 60 deg. Fahr. in the winter and much higher in the summer, ideal conditions for rapid vaporization exist at all times, and it is safe to assume that a very short time after the gasoline is exposed to the air, as it floats on the sewage, it is turned into vapor. If this assumption is true, very little liquid gasoline flows out of the sewers, and it remains to determine what becomes of the vapor formed from it. This vapor is much heavier than air and consequently will not escape through the openings in the manhole covers, nor through the air outlets of the house drains, all of which are above the sewer. The only opening for its escape, therefore, is the opening at the sewer outlet. Many of these are submerged for a considerable period each day, and even when free a moderate wind blowing into them will overcome the current of air caused by the flow of the sewage and prevent any large discharge of vapor in that direction during those periods.

Where steam or hot water is discharged into the sewers, still other conditions arise. The high temperature will increase the rapidity of the volatilization and expand and thereby reduce in weight both the air and the vapor; but whether this will bring the specific gravity of the vapor or the mixture of air and vapor below that of the outer air so that it can escape upward would have to be determined by experiment. If it did, this might account for the escape of some of the explosive gases.

ILLUMINATING GAS

Another complication is the presence of illuminating gas in the sewers; this contains but a trace of oxygen and its entrance would drive out the air and cause a mixture that might explode under very different conditions from those required for gasoline vapor alone. It is probable that it would extend the upper limit in the explosive mixtures previously given and thereby increase the probability and frequency of explosions. Another danger of the presence of illuminating gas is its adaptability to act as a train to lead a flame to an explosive mixture of gasoline vapor and air. This mixture being heavier than air remains in the bottom of the sewer and a flame or spark generated at the surface is not likely to reach it. Illuminating gas is light and is apt to rise through manholes and other openings where it is exposed to the various methods of ignition possible on the street surface. When so ignited it might carry the flame into the sewer to an explosive mixture of any kind and be the secondary cause of a violent explosion.

It is estimated that there are in New York City between 2500 and 3000 garages, besides a large number of dry-cleaning establishments, and perhaps other places where a substantial quantity of gasoline is used. In the garages are washstands upon which the automobiles are cleaned in which process substantial quantities of gasoline are used to remove the heavier oils and dirt from the machines, which, together with the water, are discharged into the house sewer. In addition gasoline is often accidentally spilled, and is also deliberately discharged from tanks and other vessels in which it has become too dirty for use. Very much the same thing occurs in the dry-cleaning establishments, where the gasoline when clean is used for white goods, then for darker ones, and when it becomes too dirty is permitted to run into the drains.

Gasoline in Sewers

Until 1906 the disposal of gasoline into sewers was not prohibited in New York, but in that year a number of serious explosions in sewers caused the passage of an ordinance which prohibits a discharge of any inflammable liquid into the sewers, with a penalty of fine or imprisonment.

The fire-prevention bureau of the Fire Department prescribes the installation of oil separators before a permit to use a building for a garage is granted. Strict rules for the use of a building for a dry-cleaning establishment also exist. Disobedience of these rules is a misdemeanor and is punishable as such.

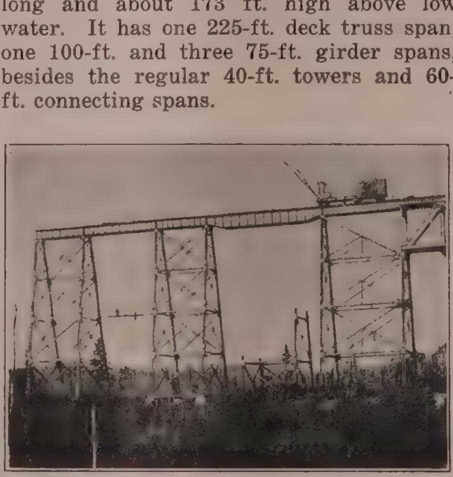
In spite of these drastic regulations and the refining companies, the explosions continue, although their frequency has diminished. The general ordinance, if enforced, would be an absolute preventive.

Mr. Hufeland has not been able to find any method of automatically detecting the presence of gasoline in sewers, either by chemical or mechanical means. Various methods more or less complicated have been proposed for field tests, none of which is simple enough to be put into the hands of sewer workmen generally. All of them require careful handling, not only in use but in transportation to the point where they are to be used, and judgment in applying the test. The simplest is an ordinary automobile tire pump used to inflate a rubber balloon with air pumped from a sewer and then forcing the air from this balloon against a lighted match to see if it is inflammable or explosive. The examination of a sewer, where the sense of smell has indicated the presence of gasoline and made such a test seem prudent, must be under the supervision of intelligent and experienced men and is exceedingly dangerous in any other hands. Where the test has given positive results, attempts at exploration without an artificial breathing apparatus and the utmost care in the use of lights must be considered most hazardous.

Erection of River du Milieu Single-Track Bridge

Long Plate-Girder Span for Canadian Transcontinental Railway Was Erected on One of Regular Towers Moved to Temporary Position in Center of Span

In the erection of the River du Milieu Bridge of the Transcontinental Railway, Canada, ordinary derrick-car methods of handling short spans and towers were supplemented by the utilization of a tall permanent steel tower, borrowed from one end of the structure and temporarily assembled midway between two other towers to serve as falsework on which a long girder span was delivered and from which its second tower was erected. The bridge is located 97 mi. west of the Quebec Bridge and is a single-track plate-girder viaduct 1198 ft. long and about 173 ft. high above low water. It has one 225-ft. deck truss span, one 100-ft. and three 75-ft. girder spans, besides the regular 40-ft. towers and 60-ft. connecting spans.



REMOVING TEMPORARY TOWER

The truss span was erected on falsework and the remainder of the structure was erected in advance by the derrick car, except in the case of the 100-ft. span, which was beyond the regular capacity of the car. Accordingly, after the end span and first tower were erected, the derrick car advanced over them and erected in front of the tower, in a temporary position, one of the steel towers for permanent use further on in the viaduct. Cribwork was built on the girders of this temporary tower and wooden stringers laid on it, enabling the derrick car to advance and erect in its final position the first bent of the second tower for the 100-ft. span, which was braced to the temporary tower by wooden longitudinal struts trussed with steel rods.

After the erection of the first bent of the second tower the 100-ft. girders, weighing about 39 tons each, were brought out on the service track, over the temporary tower, and lowered to final position on the columns of the permanent towers. The temporary tower was then dismantled and removed, and the derrick car, advancing on the completed portion of the viaduct, erected the successive tower bents and girders in the usual manner. The remaining towers were erected as already described, a single bent at a time, and braced back to the completed structure. The viaduct contains about 1700 tons of steel, and erection was commenced May 16 and completed Oct. 1, 1913.

R. F. Uniacke is the bridge engineer of the railway company and the superstructure was fabricated and erected by the Dominion Bridge Company, of which James Finley is superintendent of erection.

Book Reviews

The report of the Chicago City Waste Commission has been printed in a 69-page pamphlet. The pamphlet contains a brief résumé of the commission's findings and the full report, with many valuable tables, rendered to the commission by Irwin S. Osborn and J. T. Fetherston. T. McLean Jasper, secretary, states that a few copies are available for general distribution.

The U. S. Geological Survey has issued a 136-page index of the publications of the Survey. Complete lists of publications, with the exception of topographic maps, are indexed under the following heads: Annual reports, monographs, professional papers, bulletins, water supply papers, mineral resources, topographic atlas of the United States—folios and separate sheets; geologic atlas of the United States—folios. There is, in addition, a finding list by subjects and another by authors. (Washington, D. C., U. S. Geological Survey.)

Comment was made in this journal on Aug. 22, on the pamphlet on "Camp Sanitation and Housing," recently published by the California Commission of Immigration and Housing. A less elaborate but instructive pamphlet on "Cannery Labor Camps" has been issued by the New York State Department of Labor. While intended primarily to govern the camps used by the cannery industry in the rush season, the rules are equally applicable to contractors' camps. The rules occupy only five pages of a 6 x 9-in. pamphlet. Copies can be secured by addressing the New York State Department of Labor at Albany or the New York State Industrial Board, 381 Fourth Ave., New York City.

The U. S. Geological Survey has issued recently the following pamphlets: Water Supply Paper 327, 84 pages, "Surface Water Supply of the United States 1912, Part VII, Lower Mississippi River Basin," by Robert Follansbee; Water Supply Paper 339, 105 pages, "Quality of the Surface Waters of Washington," by Walton van Winkle; and Water Supply Paper 345-E, 13 pages, "A Method of Determining the Daily Discharge of Rivers of Variable Slope," by M. R. Hall, W. E. Hall and C. H. Pierce. The last bulletin points out that rapidly rising and falling streams have different slopes for the same gage height depending upon the river rising or falling and that, therefore, a rating curve based only upon the gage height may be seriously incorrect. It is recommended that a "normal" rating curve be established from which the actual discharge can be calculated by means of given formulae. (U. S. Geological Survey, Washington, D. C., or Government Printing Office, Washington, D. C.)

The Bureau of Standards has recently issued Bulletin 49 entitled "Safety Rules" to be observed in the operation and maintenance of electrical equipment and lines. General rules are addressed to the employer and to the employees followed by those rules under separate headings which refer to special classes of employees. It is intended that employees should thoroughly familiarize themselves with all the genera rules as well as those which relate to thei particular work. While all the rules find application in the larger industrial or privat plants or moderate-sized utilities, some d not apply (or apply less fully) to the smaller organizations. It has seemed unwise, however, to attempt to restrict the scope of the rules to those which are applicable to the smallest organizations or to the simplest classes of electrical work, since the number of workers so employed is small, compared with the total number to whose work uniform rules should apply. These rules do not cover requirements for the construction, installation, and maintenance in safe condition of electrical lines and equipment. Such rules, which are also necessary for the safety of employees and the public, will be included in a separate set. (Department of Commerce, Bureau of Standards, Washington, D. C., or Government Printing Office, Washington, D. C.)

Practical Calculations for Engineers. By C. E. Larard, Head of the Mechanical Engineering Department at the Northampton Institute, London, E. C., and H. A. Golding. Cloth, 5½ x 8 in.; 387 pages, 175 illustrations. Philadelphia, J. B. Lippincott Company. $2.00 net.

This is a very elementary book, the first part of which is devoted to short cuts in mathematical calculations, to simple engineering calculations and the use of various devices such as slide rules, etc. There is a brief treatment of some of the principles of mechanics, after which appear some elementary calculations on the steam boiler and engine. The engineering calculations are based entirely on English practice and are so brief as to be of little value especially to the American engineer. The reviewer cannot see that the book is of any particular value as an engineering text.

Abwasserreinigungsanlagen Ihre Leistungen und Ihre Kontrolle vom Chemisch-Praktischen Standpunkt. By Prof. Dr. K. Thumm, Abteilungsvorsteher an der Konigl. Landesanstalt für Wasserhygiene in Berlin-Dahlem. Paper, 6¼ x 9½ in.; 92 pages. Berlin, Verlag von August Hirschwald, N. W., Unter den Linden 68. 70 cents.

(Reviewed by George A. Johnson, Consulting Engineer, New York City.)

The first chapter of Professor Thumm's pamphlet on "Sewage Purification, Operation and Control from a Chemico-Practical Standpoint" contains a brief general review of the whole question. The next two chapters are devoted to a description of methods of analysis and to the care which should be exercised in the collection of samples of sewage. The various factors affecting the results, such as season, temperature and time of day when the sample is collected, are referred to, and the standard methods of analysis adopted by the German Royal National Institute of Water Hygiene are described.

In the fourth chapter, which constitutes the greater part of the book, the different methods applied to modern sewage disposal are dwelt upon at considerable length. Here the author goes into a detailed description of screening, septicization, different designs of sedimentation tanks and their operation, the chemical precipitation of sewage and the extent of its use in actual practice, the difference between artificial-biological and natural-biological methods of sewage disposal; and, finally, the sludge problem is considered. In his discussion of each of the above-mentioned processes Professor Thumm differentiates between the technical operation and the purely scientific management of the works and gives an outline of the duties to be performed in each case.

A number of tables showing the results of an extensive variety of analyses, such as "Constituents of Different Fresh, Stale and Septic Sewage," "Bacterial Decomposition of Sewage Containing Nitrogen and Free from Nitrogen" and numerous others, undoubtedly add to the practical value of the book.

Theory of Arches and Suspension Bridges. By J. Melan, Professor of Bridge Design at the German Technical School at Prague. Authorized Translation by D. B. Steinman, C.E., Ph.D., Professor of Civil Engineering at the University of Idaho. Cloth, 6 x 9 in.; 303 pages, 116 illustrations. Chicago, The Myron C. Clark Publishing Co. $3.00 net.

(Reviewed by F. H. Constant, Professor of Civil Engineering, Princeton University, Princeton.)

This well known work, which has already gone through three editions in the original, the last appearing in the third enlarged edition of the "Handbuch der Ingenieurwiesenschaften," Vol. 2, Part 5, 1906, needs no introduction. It has found an important place even in offices of American engineers, and its formulae and methods have been made use of in the design of some of our largest structures. It is a matter of considerable satisfaction to find so faithful a translation into our own tongue. The translator states that he has checked the derivation of all of the formulae and corrected the few typographical errors found in the original. Quantities have been converted from metric to English units, and the notation has in some cases been altered to conform more closely to our standard symbols. In a few places brief footnotes have been inserted to assist the American reader.

Melan's work is probably the most exhaustive, in this field, in any language. It would be impossible, in a brief literary notice, even to detail its scope. With characteristic German thoroughness it treats types and combinations of types not found elsewhere. Approximate as well as the more exact methods are developed. The work is intensely and wholly mathematical, with most of the derivative steps omitted. The reading is therefore exceedingly difficult, or, as the translator puts it, "it is admirably adapted as a textbook for post-graduate students in engineering or applied mathematics, for whom it will prove a liberal education in itself." Many of the analytical and graphical devices will be new to the American reader who may not be familiar with German methods. Graphical processes are used inseparably from analytical. Unfortunately the translation suffers in the small size of the greatly reduced page cuts with which the volume abounds.

An appendix covering the elastic theory applied to masonry and concrete arches is included. The method of least work is used, the thrust, shear and moment at the crown being adopted as the unknowns.

In a work of this complex character its value is greatly increased by numerical illustration. The demand of the reader in this respect will probably not be wholly satisfied in the present work. There are, however, a number of numerical examples scattered throughout the text which will be welcome interpretive guides. The most important of these is the design of Mr. Lindenthal's project for a railway suspension bridge over the St. Lawrence River at Quebec, the stresses for which are worked out in complete detail. It is accompanied by two large folding plates in the back of the book.

The book closes with an extensive and valuable chronological bibliography, mostly of German and French reference, upon the theory of arches and suspension bridges, carried down to 1904.

While one misses the beautiful typographical work of the original, the translation is clear and pleasing.

Letters to the Editor

To Assist in Increasing Export Trade with South America

Sir: The following letter has been sent out by the Society for Electrical Development with a view to arousing the interest of the manufacturer members in the problem of securing their full share of the South American market, which is attracting so much attention at present:

"While the American manufacturer cannot possibly regard the present condition existing in Europe as in any way a condition to be desired, at the same time it brings him face to face with an opportunity which he should in all justice to himself take advantage of—namely, the cultivation of the foreign market, from which, for the time being, European competitors have withdrawn. After the war is over the European countries will borrow money from the United States and pay back a goodly portion of the money so borrowed for American-made supplies of all kinds. This will be the natural result of the cessation of production in Europe, but no one can predict when the end of the war may be.

"At the present time there is the great South American market left open by withdrawal of European competition, and your attention is drawn to the possibilities of that market. If interested, the Society for Electrical Development, 29 West Thirty-ninth Street, New York City, will be pleased to secure for you whatever information it can, and if you desire literature translated into Spanish for circularizing South American countries, the society will have that done, charging you the actual cost of such service.

"Another feature to be considered is to what extent our American manufacturers can help one another in the matter of producing electrical supplies heretofore imported from Europe. What, for instance, have you been importing? Possibly the Society for Electrical Development can find an American manufacturer willing and able to make what you have heretofore been procuring from abroad, and if so we will be very pleased to render you this service."

J. M. Wakeman,
New York. General Manager.

The Inefficient Hoisting Engine

Sir: Traveling in and around New York City as much as I do, often visiting contractors who are at work excavating the new subways, erecting new buildings, bridges, etc., I cannot refrain from remarking that many a hoisting engine is eating up money unnecessarily. Usually the boiler is the chief offender, and there is every reason why it should be. The boiler is exposed directly to the cool atmosphere. There is no insulation or lagging to keep the heat in—where it belongs. But, worst of all, there are often too many leaks in the boiler seams, in the piping, or through an imperfectly fitting steam valve in the engine. There should be no leaks at all, for the great amount of good power that is wasted daily through the minutest cracks is almost appalling. Every pound of coal unnecessarily burned should be regarded by everybody as a crime against Nature. It took Nature millions of years to make the coal. The contractor and every other careless user destroys Nature's work in a minute, almost, and besides robs posterity.

To be sure, there is a limit to the care the contractor should give to saving coal. Many do not even think of it because of its minor value compared with the big work in hand. They think "just so the engine and hoists run, that's all we care." If it costs more to save a pound of coal than the pound cost originally that would be mighty poor economy.

However, it is my belief that in most cases it would pay well to devote a little closer attention to steam leaks. Stop them, and always keep the engine and boiler in good efficient running order.

New York. N. G. NEAR.

Computing Three-Level Cross-Sections

SIR: The following method of computing areas of three-level cross-sections may not be familiar to all of your readers. Figs. 1 and 2 show that it is equally applicable to cuts and fills, and the nomenclature is self-explanatory. The area of each cross-section is given by the formula

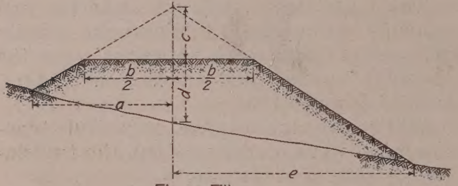


Fig. 1.—Fill

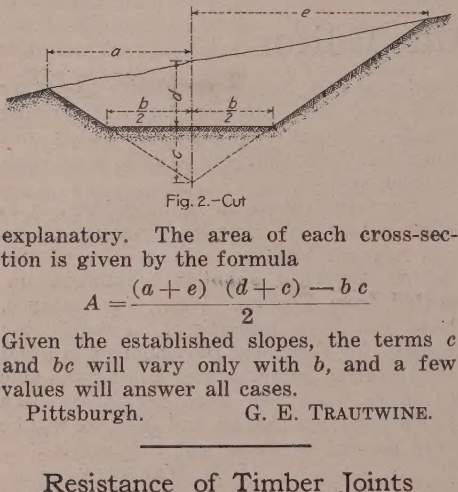


Fig. 2.—Cut

$$A = \frac{(a + e)\ (d + c) - b\,c}{2}$$

Given the established slopes, the terms c and bc will vary only with b, and a few values will answer all cases.

Pittsburgh. G. E. TRAUTWINE.

Resistance of Timber Joints

SIR: Under title of "Resistance of Timber Joints" there appears in your issue of Aug. 1, page 132, an article by Prof. Arthur C. Alvarez describing some tests of timber joints made in connection with the design of the timber frame buildings of the Panama-Pacific International Exposition. The article contains some statements which are in error and omits some important facts. Their omission has apparently led to erroneous conclusions and is apt to mislead the reader in his judgment as to the practical value of the joints.

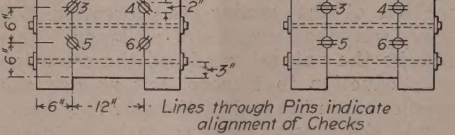
The type of joint tested is not new, having been used at previous expositions, where, however, oak was employed for the pins. In the St. Louis Exposition a working value of 800 lb. per linear inch of a 2-in. pin was used. This pressure means a working value of 400 lb. per square inch in shear on oak. As the ultimate shearing strength of white oak with the grain may be taken at 800 lb. per square inch, the engineers of the Panama-Pacific Exposition regarded oak as insufficient in strength for this purpose and set about to find a material of equivalent cost with a greater shearing strength.

The test joints were designed by the Division of Works of the exposition, and the method of testing was outlined and directed by this division, under the personal supervision of its structural engineer or his assistant.

The joints of types A and B were framed by the force account of the Division of Works and not by the W. W. Anderson Company, as stated. Joints C and D were framed by the W. W. Anderson Company, but under the inspection of the Division of Works.

The wooden pins of joints A and B were lathe-turned, and truly circular, of 2-in. finished diameter. When, as a result of these tests, Hawaiian ohia had been selected as a satisfactory material for pins, with the extra-heavy pipe as an equivalent alternate, the agents for this wood intended to ship the finished pins from their mills in the Hawaiian Islands. Shortly after this, however, their mills burned down, destroying their machinery and a large part of their stock. For this reason the first pins delivered for the construction of the Palace of Machinery were of poor stock, badly season-checked and, in addition, were not lathe-turned but "stuck" pins—that is, run through a machine known in planing-mill parlance as a "sticker." As a result, many of these pins were far from circular and were slab-sided, in addition to being badly season-checked. To find out to what amount such pins would decrease the strength of a joint, joints C and D were framed, using selected inferior pins. The drawing shows the nature and arrangement of these defective pins. The lower strength of the joint, as shown by the tests, was therefore to be anticipated. In actual construction the piles of pins were carefully gone over by the inspectors and all inferior pins thrown out. It is safe to say, therefore, that these two joints are not typical of any joint now existing in the exposition framing.

At a somewhat later date—in fact, nearly a year—a rival firm of hardwood dealers was desirous of introducing one of their products, Australian hickory or spotted gum. To this end a firm of contractors, not the W. W. Anderson Company, fabricated two joints, E and F, using this Australian hickory, and not hickory as stated. The framing was not supervised by the exposition inspectors, and was very poorly done. The poor fit noted in the sketch entitled "Joint-Opening Dimensions" (Aug. 1, page 133) was due to the carpenter attempting to bore the holes from the two sides and the holes not meeting at the center of the stick. The low strength of these two joints was undoubtedly due primarily to this poor framing. However, the Australian hickory pins appeared to be softer and to suffer more deformation than the ohia. It might be noted that these pins also were "stuck" and not truly circular.



Lines through Pins indicate alignment of Checks

JOINTS C AND D

Joint C: Pins 1-4, average check; pins 5 and 6, bad check.

Joint D: Pin 1, 1/16 in. shy on one end, not checked, slab-sided; pin 2, slab-sided but has full section; not checked; pin 3, average check, slab-sided; pin 4, average check, special grain; pin 5, extremely bad checks, ¾ in. deep, open ⅛ in. for full length of pin; pin 6, nearly as bad as pin 5.

The washers used in joints A and B were of various sizes, some standard malleable iron and some cast iron, the exposition standard washers having not yet been developed.

While the efficiency of these test joints, as stated, ranges only from 18 to 31.5 per cent., it does not follow that this is the maximum efficiency possible. It is obvious that with more pins a greater load could have been carried.

The writer believes that the ultimate resistance per pin in a joint of this type will undoubtedly decrease somewhat with the increase in the length or with the number of pins. Support to this conclusion is given by some tests made recently on two joints of type C, using 2-in. lathe-turned pins of red Australian iron bark, in which the efficiency per linear inch of pin was 88 per cent. of that of joints B7 and B8. The rate of this decrease in strength per pin could only be definitely determined by an extended series of tests, and it would be unfair to conclude that the small efficiency of 60 per cent. as shown by the four large defective joints of these tests is to be expected with good pins and average workmanship.

It might be noted here that the exposition engineers have recognized a possible decrease in efficiency of pins with a large number of long pins, and in such cases have decreased slightly the working value per linear inch. In conclusion it may be said that after an experience of framing joints aggregating some 160,000 lin. ft. of 2-in. pins the writer believes this type of joint to be one of the most economical and efficient tension splice joint for timber that can be devised.

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THE LOG OF THE ANCON, the first mercantile marine ship to pass through the Panama Canal from the Atlantic to the Pacific, shows the following for the westbound trip Aug. 15:

A.M.	
6:45-7	Cast off lines at Cristobal and proceeded to Gatun locks.
8:15	Entered lower lock.
8:40	Entered second lock.
8:57	Entered third lock.
9:10	Entered Gatun Lake.
11:12	Entered Culebra cut.
P.M.	
12	Passing Cucuracha slide.
12:45	Entered Pedro Miguel lock.
1:19	Passed out of Pedro Miguel lock.
1:27	Entered upper lock Miraflores.
2:25	Entered lower lock Miraflores.
3:30	Entered Pacific sea level.
4	Entered Panama Bay.
4:42	Anchored off Balboa docks.

The return trip Aug. 23 required about half and hour less time than the one above recorded. The lines at Balboa dock were cast off at 7.02 a. m., and the ship was made fast at her berth in Cristobal at 4.35 p. m. An hour gained at Miraflores lock was partly lost at Gatun.

An Analysis of the Fundamental Character of the South American Trade Problem

Views of the Special Committee Appointed by the National Foreign Trade Council at the Outbreak of the War

IN the hope of correcting prevalent misconceptions regarding the trade of the United States with South America and opportunities for its extension, the National Foreign Trade Council has issued a statement calling attention to certain fundamental conditions surrounding that trade, which must be improved in order to accommodate existing trade, to say nothing of future business.

The chairman of the council is James A. Farrell, president of the United States Steel Corporation, and it consists of thirty-five nationally representative manufacturers, merchants, railroad and steamship men and bankers, representing all sections of the country and collectively standing for the general interest of all elements engaged in foreign trade.

At the outbreak of the war a standing committee of New York members was appointed to consider foreign trade problems as they arose. As a result of the committee's observations the following statement has been issued:

CHARACTERISTICS OF SOUTH AMERICAN TRADE

Under the influence of glowing generalities as to the "wonderful opportunities" for extension of United States trade with South America the public should not lose sight of certain fundamental conditions surrounding that trade, which must be improved. The prizes of Latin-American trade will not fall gratuitously into our hands. Every nation now enjoying a large per capita foreign trade has attained it only by systematic effort and sacrifice.

The South American trade problem cannot be appreciated without analysis of its fundamental character.

The normal elements of South America's foreign trade have been:

1. Agricultural, forest and mineral exports, constituting raw materials necessary to the life and industry of Europe and the United States.
2. Imports of manufactures.
3. European investments in South America, creating a market for European manufactures.
4. European banking, providing these investments and handling South America's trade with the United States, as well as with Europe.
5. European steamship lines, trading houses, and sales organizations serving a part of the United States' as well as Europe's South American trade.
6. A limited number of the United States' ships, trading houses and sales organizations.

The effect of the war upon this commerce has been:

1. Curtailment of the foreign market for South American products, due either to diminished purchasing power of the warring nations or to their inaccessibility, as in the case of Germany.
2. Curtailment of South America's source of supply of manufactures, as in Germany.
3. Shrinkage of South American purchasing power through curtailment of European investment in South America, entailing suspension of transportation, industrial, agricultural and mining projects, which normally consume foreign manufactures.
4. Dislocation of London exchange, the universal currency of South American foreign trade and declaration of moratoria, rendering either impossible or expensive payments or collections in London bills of exchange.
5. Interruption of steamship communication, due to German marine disappearance from the sea, and, for a time, prohibitive war risks.

As a primary fact South America's purchasing power is thus seen to dwindle toward the point represented by the value of her exportable products. A certain proportion of these must be utilized to meet her obligations of interest on European loans.

Although the United States, in the year ended June 30, 1914, purchased from South America merchandise to the value of $222,677,075, and sold in return only to the value of $124,539,909, an adverse trade balance of $98,037,066, our Southern neighbors may naturally seek expansion of their exports in this direction. The future alone can determine whether this is possible. It is noteworthy that one commodity, coffee, during the last fiscal year constituted, in value, one-third of our total imports from South America. And this was a decline from the coffee import figures of 1912 and 1913.

SOUTH AMERICA'S BUYING POWER

How great an opportunity has the United States to sell South America merchandise hitherto bought in Europe? Any answer must take into consideration the already proved fact that the European war diminishes South America's purchasing power because it reduces European investment. Whether the curtailment of European supply of manufactures exceeds the curtailment of this purchasing power will largely determine the extent of our opportunity to increase exports to Argentina, Brazil, Chile and other states.

Germany, as a source of supply of manufactures, is now cut off, but this by no means delivers German trade into our hands. The United Kingdom, although at war, impressively keeps open and traveled its world trade routes and with banking and shipping resources that we utterly lack appreciates all opportunities for the capture of German trade.

Nor is European trade easily uprooted even by the shock of war. British commerce with South America is well grounded on vast investments in railways, industrial, agricultural and mining enterprises, and government loans, an estimated total on Jan. 1, 1913, of $3,376,495,837, yielding about $160,000,000 in annual interest.

Trade naturally follows investment, but British, French and German investors have not rested content with the natural outworking of this economic law. In recent years they have systematically fortified their South American trade by stipulating that materials from the country providing the funds be preferred in the resultant construction and equipment contracts. Thus British-financed railroads often use exclusively British rails, rolling stock, etc.; power plants built with German capital are equipped only with German electrical machinery, etc. The practice closed many commercial doors to the United States.

Will they remain closed? This depends upon whether European capital continues almost exclusively to supply the funds for continuance of these projects. Should the burdens of war decrease Europe's investing ability, or even regardless of that contingency, the investors of the United States may well conclude that judicious investment in South American railways, industries, plantations, and mines not only offers adequate profits but will open and protect new markets for manufactures and certain natural products such as oil, coal and lumber. A great part of the funds thus loaned need never leave the country but will be expended here for American manufactures.

While the American public is not educated to foreign investment, and the country is still a borrower in the world's financial market, it should be remembered that the new tariff has precipitated many American industries into world competition. Our domestic prosperity, the welfare of millions of workers, increasingly depends upon the success of export trade. With our commercial operations thus forced to encircle the globe, capital will scarcely remain cloistered within our own borders.

BANKING FACILITIES

Not only does our future in South America depend upon improvement of our banking facilities, but the transaction of business already obtained has been halted by the disruption of London exchange. For years London has been South America's banker, and ninety-day bills on London the medium of settlement of export and import business not only with Europe but with the United States as well.

Having so long depended upon London banking mediation, which includes not only British but German and French branch banks at London, exporters and importers here and in South America have great difficulty in establishing direct banking relations.

We owe South America far more than South America owes us. The trade balance is heavily adverse to the United States. Since South American interests owe heavily at London, they naturally desire that the United States pay at London for its heavy imports of coffee, rubber, nitrates, etc. Importers, therefore, are obliged to transfer funds to London, a difficult and expensive process at the prevailing high rates of exchange. Of course, this money is not shipped on from London to South America. London discharges the obligation in British manufactures, thus effectively alienating to the United Kingdom the selling power which we should derive from heavy purchases of South American merchandise. In a healthful trade the United States should more largely discharge its indebtedness to South America by increased exports. Obligations for imports payable at London not only prevent this but siphon gold from our banks to Europe.

The most conspicuous evidence of our disadvantage is seen in the trade with

Brazil. During the last fiscal year American imports from Brazil were valued at $101,329,073, but we sold to Brazil in return merchandise valued at only $29,963,914. Vessels have delivered coffee, rubber and other Brazilian products in the United States and loaded with cotton and grain which they have transported to Great Britain, loading in British ports with British manufactured goods which were carried to South America, thus completing the triangle.

While we are willing and able to pay for South American products, our manufacturers and trading houses are reluctant to ship goods to the sister republics, many of whom have declared moratoria. Manufacturers and exporters declare they do not know where their money is coming from. As a matter of fact, the exporter's money ought to come from his next-door neighbor —the importer of South American merchandise.

We are certainly at a disadvantage if our indebtedness is used to pay for British manufactures exported to South America while our own manufactures remain congested on our docks for lack of sound credits. The necessity of machinery to bring together the importer of South American products and the exporter of our manufactures is apparent. Toward this goal various banks are seeking to work, but the field is new. The task is complicated by the lack of co-operation between exporters and importers as well as by the absence of established American banks in South American financial centers. The new banking law, fortunately, permits the establishment of foreign branches of national banks. The National City Bank has availed itself of this authority, but the authorization of national banks to deal in acceptances of foreign paper is not yet effective. So long as it is not in operation a serious difficulty confronts the establishment here of an international discount market strong enough to support direct exchange with the neutral markets of South America and the Far East.

TRADE INDEPENDENCE VITAL

The war has demonstrated that foreign trade is a vital element in our domestic prosperity. The war has disclosed a fundamental weakness of our foreign trade's dependence upon European banking. Although neutral, our commerce has suffered, through this dependence, the rigors of war.

With the gradual resumption of ocean transportation and the control of the sea by England the equilibrium of London exchange may be restored again. Nothing is more fallacious, however, than to await this restoration as the sole remedy of the disruption of oversea commerce.

What the war has in store is uncertain. Blind dependence upon the banking mediation of any belligerent is hazardous. Our greatest opportunity lies in the establishment of those direct financial relations and the American steamship connections necessary to assure the economic independence of the trade we already have and of that which we hope to gain with increased banking and steamship facilities of our own it should be possible to pay for a greater proportion of our imports in merchandise of our own production and to retain in the United States a greater proportion of the funds due for imports.

While individual opportunities will offer themselves to our exporters, the general security and prosperity of the South American trade can be guaranteed only by the formulation of a definite policy upon the part of business men as well as the Government and by co-operation among all elements. Increased South American trade founded on anything less substantial will remain vulnerable to the changing fortunes of European finance and business.

Effect of the War upon Business Conditions in the United States

Gano Dunn Believes Increased Exports of Foodstuffs and Manufactures Will Partly Offset Capital Losses

At the outbreak of the war Gano Dunn, president of the J. G. White Engineering Corporation, was in Europe. He has, upon his return, given the Engineering Record a statement of his views in regard to the effect of the conflict upon business conditions in this country. It is as follows:

1. An enormous amount of the world's capital has already been destroyed and more will be destroyed, consequently construction enterprises and new projects of all kinds which flourish on surplus capital seeking investment will be severely checked for a long time.

2. Further destruction of capital due to the continuation of the war will probably be greater if the Allies are defeated than if Germany is defeated, since the capital of Great Britain, France, Belgium and Russia is much greater than that of Germany and Austria, and it is probable that the former nations would go far toward exhausting their greater joint resources before accepting defeat. The financial and industrial effects of the war, therefore, are involved to a considerable extent in the result of the fighting.

3. There will probably be greatly increased exports from the United States of foodstuffs and manufactures, which will mitigate and to some extent offset the tremendous capital losses in the United States resulting from the destruction of security values and the contraction of credits. There will probably be a general increase in interest rates and also probably a certain amount of American capital available for smaller construction enterprises that are near enough home to be locally known and bring out the resources of the very small investor.

4. South America will suffer severely not only through lack of European capital, which has been the principal source of supply for the development of her new enterprises and the extension of her commerce, but also through reduced capacity of Europe to take and pay for South American exports. American and Canadian markets will inevitably be benefited by the demand for such South American imports as Europe cannot supply. While these South American purchases will be of much benefit on account of the business they represent, they will be of more value because of the new channels of trade they will open up and the new connections they will establish. Their immediate value should not be overestimated, however, in view of the reduced buying power the South American countries will experience from the reduction of their usual exports to Europe.

5. Any forecast at this time can be presented only as an offhand opinion, since the consequences of the great struggle will so fundamentally affect American and international commerce, finance and industry that no one can see clearly the adjustments that must follow.

American Cities Optimistic Regarding Public Improvements

Conclusion Drawn from Answers of Mayors of Twenty-one Cities to Questionaire

In order to learn the prospects for municipal work in the present crisis "The American City" sent requests for views to the Mayors of municipalities in various parts of the country. Twenty-one replies are published in the September number and from them the editor of that journal has drawn the following conclusions:

"There is little tendency to call a halt in public improvements in American cities because of the European war. These Mayors of important cities throughout the United States are, almost without exception, in favor of carrying on municipal improvements with unabated vigor during the coming fall and winter. In some cities, indeed, plans are being made to do even more public work than would ordinarily be undertaken through the winter months. On the other hand, some of the Mayors express doubt as to their ability to float bond issues at the present time, or to obtain necessary funds in other ways. Because of the ease with which high-grade municipal securities can ordinarily be sold, the present problem of city finance is an unusual one. In our opinion, however, it does not offer obstacles which cannot be overcome by any city whose credit has not, for other reasons, been seriously impaired.

METHODS OF SECURING LOCAL AID

"To be sure, the bond houses which ordinarily are in the market for municipal securities are offering little encouragement at the present time in the way of commitments for new issues. Cities which wish to raise money this fall must, in most cases, look to their local bankers or citizens, rather than to the large financial centers, for assistance. There are various possible methods of securing local aid:

"1. Short-time notes might be issued at a rate of interest attractive to the bankers, these notes to be retired by a subsequent issue by the city of bonds under a more favorable market.

"2. Bonds of the city might be issued immediately and sold to local bankers, who could use them as security for emergency currency. Such a transaction might be of benefit both to the city and to the local banks; for the latter could no doubt dispose of the bonds at a premium when money becomes more plentiful. To protect the city's interests, such bonds should either be issued for comparatively short terms or should contain the option of retirement by the city in advance of date of maturity.

"3. In some cases it would doubtless be possible—as is, indeed, the custom under ordinary financial conditions in certain cities—to make payment in city bonds to manufacturers or contractors for public work. Such a plan, if adopted, must be handled in a conservative manner, lest the city's credit be depressed by the resale of large quantities of such bonds to the public at inopportune times."